

NATIONAL CHARACTER¹

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I. THE PROBLEM AND ITS DIFFICULTIES

IN popular thought and in serious historical and political studies the existence of national characteristics and even of national character, in the sense of coherent group of traits exhibiting some measure of permanence and continuity, is undoubtedly frequently taken for granted. An American statesman in speaking recently of the trend of the war predicted a German defeat by internal collapse, because as he said 'the Germans will not take it'. The novelist Conrad, when asked in 1914 what England would do, felt confident in asserting that if England did come into the war then, no matter who might want to make peace at the end of six months at the cost of right and justice, England would keep on fighting for years and, if necessary, alone. In both these instances it is clear that to Germany and England is attributed sufficient continuity of character to justify prediction of their probable behaviour in given circumstances. On the other hand, when we turn to the attempts that have been made to subject national characteristics to scientific analysis the results are generally so indefinite as to raise a doubt whether the characteristics in question exist at all. It is therefore of importance at the outset to bring out the difficulties which such studies of necessity encounter.

There is, to begin with, the obvious difficulty of avoiding personal bias in observation and interpretation. The greater part of the books on the subject are *livres de circonstance*, written under the influence of particular political situations and with a view to future policy. The numerous accounts of English national character written by Germans since the beginning of the nineteenth century may be cited in illustration.²

¹ Inaugural address to the Social Psychology Section of the British Psychological Society delivered at Nottingham, 17 April 1941.

² An interesting discussion of these accounts will be found in (1), Introduction, pp. 35-51.

The earlier writers saw in the slow and organic growth of England and its sturdy independence a model for Germany's struggle and reconstruction. Later and under the influence of the new racial theories stress was laid on the ruling qualities of the Germanic peoples, and England is depicted as the noblest people of Germanic race. Later still, with the emergence of the theory of *Realpolitik*, there is a strong tendency to depict English character as essentially materialistic, as persistently striving for power and profit and hiding its selfish sentiments under a cloak of ethical and religious humanitarianism. This tendency was naturally encouraged during the war of 1914-18 and is clearly seen even in writers who claim, not without reason, to be capable of viewing the problem with some coolness and fairmindedness. Thus Levin Schucking seeks to show that hypocrisy is deeply rooted in English character. It is not, he thinks, to be explained as a defence mechanism against a too stringent Puritanism, because the trait is most marked in the non-Puritan sections of the English public and can be traced back to the pre-Puritan period(2). The best known work on England written after the war of 1914-18, while praising the sanity, virility and spiritual balance of the English, is yet at bottom dominated by the belief that the ruling quality of the English mind is the lust for power and that this constitutes a great danger to the world, unless it is checked and controlled by the resistance of something like an equal opponent (3), p. 506). English and French writers in dealing with the psychology of peoples other than their own show, I think, greater powers of detachment, a keener awareness of the difficulties of entering sympathetically into the minds of others, and a greater readiness to make allowance for national and personal prejudices. To give one example, Fouillée's work(4) on the psychology of peoples is generously conceived and executed, inspired by the belief that the qualities of a people are as a rule more deeply hidden than its vices and absurdities, and that the lesson of comparative psychology is to inculcate at once justice and sympathy. His study of the character of the Germans, in particular, is extraordinarily fairminded, though he cannot altogether avoid being disturbed by their growing militarism and chauvinism. A survey of the works dealing with national characteristics suggests, I think, that the errors due to bias can be to a large extent corrected by a comparison of the views that writers of different nations have of other nations than their own, while occasionally the picture they paint of other nations may also serve to reveal something of the mentality of their own. In this branch of social science as in others impartiality is very much a matter of degree, and in a measure

the personal equation can be allowed for by paying attention to the historical conditions likely to affect the results of the enquiry.

Another set of difficulties arise from the great complexity of national groups and the fact that they differ widely in inner unity and homogeneity. There appears to be no generally accepted definition of nation, but for the present purpose we may say that a nation is a group of people, inhabiting or associated with a given territory, who regard themselves as a unity and have the will to give expression to that unity in political independence or at least in a measure of cultural autonomy. It is obvious that this definition would cover groups differing widely from one another in inner cohesion and complexity of structure. We cannot assume that all peoples who call themselves nations have a distinctive character, still less that this character is natural or native or equally diffused in all portions of the people.¹ A differential or comparative psychology of nations would have to establish a serviceable classification of types of nationhood. Such a classification would have to take into account (a) the type of political unity, e.g. whether federal or centralized, (b) degree of social differentiation and type of class structure, attention being given in particular to the emergence of the middle classes, (c) degree of cultural homogeneity, with special reference to language and religion, (d) age or rather stage of maturity or growth.

Politically complex nations often have sub-nations within them, as is, for example, the case in Great Britain, and the question arises whether there is a national character common to them all. Again, in most European countries there are important local differences both of temperament and character. The Picardian differs from the Gascon, the Norman from the Savoyard, and we cannot be sure that behind these divergencies there is an underlying identity of character.² The age of the nation or its degree of maturation becomes especially important in comparative studies. The traits attributed by Tacitus to the Germanic tribes have often been regarded as specifically German; but according to modern ethnologists these traits are common to many primitive peoples. There may be differences also in speed or rate of maturation, and it has

¹ Cf. Nietzsche's remark: "That which is at present called a nation in Europe, and is really rather a *res facta* than *nata* (indeed, sometimes confusingly similar to a *res facta et picta*) is in every case something evolving, young, easily displaced" ((5), p. 208).

² An interesting attempt is made by Halbwachs, *Les causes du suicide*(6), to calculate the 'dispersion' of suicides in the various regions of several European countries. He shows that in this respect there is greater uniformity in England than in other countries, the tendency to suicide being more evenly distributed in the counties of England than in the departments and provinces of France, Italy and Germany.

been argued, for example, that the German people has matured very slowly and that it is only in recent times that its own nature has been able to express itself over against the numerous foreign influences to which it has been for long subjected (cf. (7), p. 39). The degree of social differentiation is especially important in dealing with the non-industrial peoples. Most of the characteristics attributed to the Poles, for example, appear to refer only to the Polish nobility, while of the bulk of the population we know little or nothing. In the more differentiated peoples it is perhaps an open question whether class characteristics are not at least as important as the national characteristics, and it is arguable that in some cases members of the upper classes have more in common with their opposite numbers in other nations than with the lower classes in their own. It is clear that a comparative differential psychology would have to take into account these considerations. Meanwhile, attention is most usefully confined to nations of long standing and in comparative studies to peoples of similar levels of cultural development. It must be confessed that most studies of national characteristics have so far been very general in nature and have hardly even begun to deal with the problems suggested by the above considerations.

There is still another sort of difficulty which arises out of the lack of a generally accepted theory of the structure of individual character. Fouillée's work is based on the old theory of the temperaments. Thus he regards the Spaniard as *bilieux-nerveux*, the German as *flegmatique*, the Frenchman as *sanguin-nerveux*, while he also finds important differences in sympathy, strength of will and in intelligence ((4), pp. 144, 254, 456). McDougall bases his account on assumed differences in the intensity of the basic instincts, e.g. gregariousness, assertiveness, submissiveness, and in temperamental traits like the tendency to introversion or extroversion (8,9). Others work with the concept of types as when Madariaga regards the Englishman as the 'man of action', the Frenchman as the 'man of thought', and the Spaniard as the 'man of passion' (10). Whatever the starting-point of the enquiry, the problem is complicated further by our ignorance of the relative importance played by hereditary and environmental factors in the formation of character. Temperament is often regarded as the innate element in character and, in so far as national characteristics are held to be constant, this constancy is attributed to the persistence of temperamental traits. But there seems to be little agreement as to what is to be included under temperament, and the study of its hereditary basis appears to be still in its infancy. Again, it seems to me very doubtful whether differences in behaviour among different

peoples can be safely attributed to differences in instinctive endowment. The French are held to be more sociable than the Germans, and this is explained by McDougall, for example, as based on a difference in the intensity of the gregarious instinct. But it may well be that the difference is rather in the way gregariousness or sociality expresses itself in the two nations. The French meet to talk, to exchange ideas; the Germans to drink, to make music, to go on excursions. Further, those who are not satisfied with enumerating single traits of different peoples and wish to show how these traits unite to form distinctive characters conceived as systems must find the problem of the relative importance of hereditary endowment and environmental influences still more difficult, since very little appears to be known with regard to the genetic basis of the organizing principles of character and personality. In view of all these uncertainties in the theory of individual character, it is not surprising that the psychology of peoples has found no secure foundation and that the bulk of it consists of divination rather than observation, intuitive impressions rather than scientific analysis and interpretation. Despite all these difficulties and obscurities it seems to me to be a mistake to dismiss the whole theory of national character as an 'illusion' (11). The dangers arising out of bias and the intrusion of value judgements are not peculiar to this branch of study but beset all social studies in varying degree and can be to a great extent watched and guarded against. The difficulties of comparative study can only be removed gradually as our knowledge of the different nations grows and is supplemented by more detailed study of the character of groups within the nations. The problem of the genetic elements in national character has been, as we shall see later, much obscured by the assumption that national characteristics are racially determined. This has led to much futile argument. In all probability it would be much better to defer discussion of the part played by genetic factors until a better technique of record and observation has been developed and the relations between individual and social psychology have come to be more clearly defined.

II. THE DEFINITION OF NATIONAL CHARACTER

I propose now to enquire what exactly is understood by national character. Strictly speaking, I suppose, only persons can be said to have character and, if we follow Stout in saying that "Character exists only in so far as unity and continuity of conscious life exists and manifests itself in systematic consistency of conduct" (12), p. 653), then nations

cannot be said to possess character. Nevertheless, nations like other groups behave in distinctive ways and if their behaviour shows some unity and continuity we may perhaps speak of a group character without committing ourselves to any theory of a group mind or group personality. In practice there seem to be two senses in which the term is used. It may, first, be used to indicate differences in the distribution of certain traits or perhaps of types in different groups, as when we say that the Germans are more docile than the English or that the French are on the whole more articulate than the English, or that the Irish temperamentally dislike regimentation. This could perhaps be called common character, and it is clear that a scientific study of it would involve a statistical examination of the frequency with which traits are distributed in different groups. But, secondly, group character is also used to indicate the behaviour patterns of the group as a whole, that is the nature of its organization as embodied in its institutions, its collective achievements and its public policy. It is then assumed that the institutions in the long run depend upon the character of the component individuals as shaped by their interactions. Clearly there is a very subtle and complex relation between institutions and the character of the individuals sustaining them, since on the one hand men make their institutions but, on the other, the institutions make the men. Hence it seems misleading to say, for example, with Madariaga that it is not English education which explains the Englishman, but the Englishman English education, or that the Reformation and the Roman Catholic Church are not to be considered as causes but as effects of national character. The relation is one of reciprocal interaction rather than of causality. The situation is complicated by the fact that institutions may not reflect the character of all the members but perhaps only of powerful sections, and that, once formed, they tend by unconscious processes to select the type that suits them. In this way many qualities in a population may remain dormant or repressed until a change of circumstances brings them into play, while again the reaction against a type that has become unduly dominant may sometimes be an important cause of change. It is thus possible for great and revolutionary changes to take place in the institutions of a nation without a parallel change in the underlying qualities of the mass of the nation. It follows that at any one moment of time we cannot safely infer the character of a people from its institutions or public policy, and that for this purpose it is necessary to know the history of the institutions and the portions of the people that have been dominant in shaping them. A great deal of what foreign writers have to say about

English character is based on their impression of public school mentality. But the public school tradition dates only from the middle of the nineteenth century and few of the 'Prep' schools which are an integral part of the system date further back than 1870. In dealing with the psychological basis of religion in England the class structure of the country becomes of great importance, since it is generally agreed that, on the whole, Anglicanism has been the religion of the gentry and of the villages, while non-conformity is more characteristic of the middle classes and the towns. The range of variation in character has to be taken into account. Most continental observers find English character homogeneous throughout the different classes and they attribute this to the lesser rigidity of the class structure of England as compared with, say, that of Germany. But this is hardly more than a subjective impression and more accurate methods of observation and record would no doubt reveal both local and class differences. The transition from the institutions of a people to its underlying character thus raises many difficult problems.

Similar difficulties arise when the literature, the science and philosophy of a people are taken as a basis for the psychology of peoples. Fouillée thought (4), p. 547) that a nation expresses itself above all in its *élite*, its representative men: "If you leave out of consideration the *élite* of France there is no more France; France is reduced to the level of those peoples who have no history." "There is no national poet of any great nation", it has been said, "who is so completely representative of his own people as Shakespeare is representative of the English", and it has even been argued that his acceptance by the world is due not so much to the greatness of his genius as to its English quality (13), chap. vi). On the other hand, of Dürer and Bach a German writer has said that they are representative rather of Protestantism than of Germany (14). It is difficult to see how at the present stage of our knowledge such problems can be resolved. In any case, the study of national traits as revealed in its 'representative' men must be supplemented by a study of the mentality of the people at large, especially as revealed in proverbs, folk lore and especially in wit and humour.¹ There is here clearly an enormous field of study.

The bulk of the more popular works on the psychology of peoples is concerned with national character in the first of the two senses distinguished above, namely the wide prevalence of certain traits in the group.

¹ Cf. Baldwin's remark: "Understand English humour, and you have gone a long way to understanding the Englishman" (15), p. 22).

They abound in rough generalizations and often exaggerate both the permanence of the characteristics and their wide diffusion. The English have been described since Froissart as 'taking their pleasures sadly' and their gravity has been contrasted with the gaiety of the French. But already Emerson noted that their 'brows were no sadder than their neighbours of northern climates', and as compared with Americans he thought them cheerful and contented. The experience of the war of 1914-18 belied the traditional opinions about the psychology of peoples. Clemenceau remarks: "The Englishman was noted for his calm, but English soldiers tended to be more hysterical than others, the Americans were supposed to be so quick and they were so slow. The French were supposed to be gay and they were solemn" (11), p. 39). The Chinese are reputed to be impassive and reserved in the expression of their emotions, and even a careful anthropologist like the late Professor Seligman felt justified in describing them as introvert. He found, however, on closer enquiry that what he took to be an inborn trait of the Chinese was rather a mode of behaviour set up as a standard for the governing and literary classes and never adopted by more than a small proportion of the population (16), p. 86). So again the tradition of the Austrian as charming, easygoing and kindly was shaken by the brutalities committed after the triumph of the Nazis. Examples could easily be multiplied of similarly crude generalizations and especially of the danger of predicting the future behaviour of peoples on the basis of what is supposed to be their permanent and even innate character. Yet even when allowance is made for local and class differences and for the effects of changing circumstances there is often some truth in the generalizations reached by careful observers, and it would, I think, be a mistake to deny the existence of national traits in the case of nations of long standing merely on the ground that so far they have not lent themselves to exact analysis or quantitative measurement. Better results may be expected when more is known of the genetics of character and when a more reliable technique has been elaborated for observing and recording group differences in behaviour.

The indirect method of studying national characteristics by an analysis of the psychological basis of the collective achievements of peoples has undoubtedly proved more fruitful than the direct method based on the observation of individual behaviour. As an example I want to consider briefly some of the views that have been put forward regarding the character of the English and the Germans. With regard to two qualities of the English mentality there is universal consensus among

observers both English and foreign, namely, its empiricism and individualism. Apart from the contributions made by English thinkers to empiricism regarded as a philosophical theory, the empirical habit of mind is seen in all spheres of English life. English law and English politics are based on the empirical method of dealing with particular problems as and when they arise. There is a disinclination to formulate general principles and piece-meal enactments are preferred. Even when, as has frequently been the case, legislation is undertaken after special enquiry, the enquiry is deliberately limited in scope and little attention is given to the requirements of general theory or systematic connexion.¹

English international policy is especially characterized by its tentative, piece-meal method. It avoids legal rigidity and has no faith in general solution or long-range planning. An acute French observer has seen in this trait one of the standing difficulties of Franco-British collaboration. In contrast with the habit of the English diplomatists to confine themselves to the immediate and particular, the French mind reaches out for the general and has a longing for clear-cut and logically consistent solutions. That there is a certain consistency in British foreign policy over long periods of time is due in the main to the geographical and economic situation of Britain and certainly not to the existence of deep-laid plans pursued year in and year out with Machiavellian cunning. If the British Empire was not exactly built up in a fit of absence of mind neither was it the result of a deliberate policy carefully planned beforehand and applied methodically by successive governments. The early French colonial acquisitions were also fortuitous and occasional and not the results of conscious planning. But this cannot be said of the colonial policy of the Republic which appears to have been due to a political plan carefully studied and applied with persistence in the face of great difficulties (cf. (18) and (19), p. 25). German colonial policy was, of course, still more consciously and deliberately planned, with frank recognition of its economic nature and with the open support of financial and commercial interests. In internal policy the same characteristics of the English mind can easily be traced. The principles of democracy have never been clearly formulated and deliberately applied. The issues fought over have been particular changes in which only the historian can discern a steady tendency. The history of the Church of England also shows a quality essentially connected with empiricism, namely a dislike of pushing principles to their logical conclusions in face of the complexities of life. The dislike of the English for rigid principles and their distrust of

¹ For numerous illustrations compare especially Boutmy (17), chap. IV.

abstractions is sometimes attributed by continental writers to a lack or weakness in the power of generalized thought. This seems absurd in view of the contribution of the English to science and philosophy. But it is true that in dealing with the practical problems of life the English mind prefers to proceed tentatively, by trial and error, and in this it appears to me to show a better and sounder sense of method than those who put their trust in dialectics.¹

The second quality of the English mind, its individualism, can also be readily traced in the various spheres of the national life. It can be seen in the spirit of the English law which is a law of the liberty of the individual subject, in the strength of local government and resistance to centralization, in the stress laid by Puritanism on the autonomy of the individual and in a very widespread and deeply rooted impatience of compulsion and restraint. Continental writers, while stressing the individualistic tendencies of English institutions, have nevertheless also urged that this individualism has its limitations. Both Madariaga and Dibelius think that the tendency of English education and especially of the Public Schools and the Universities has been to standardize behaviour and to repress the types that threaten to diverge from the norm. A recent writer, very friendly to England, has said that as compared with pre-Hitler Germany "the English type in all classes lacks a certain touch of individualization" (21). I suspect, however, that these writers are impressed rather too much by a certain conventionality in the behaviour of some of the educated classes in England, which on closer analysis proves to be perfectly compatible with a plentiful variety and even eccentricity of character.

The individualism of the English is closely associated with a capacity for spontaneous organization, and indeed a great deal that is distinctive in English society rests on the power of combining an intense individualism with practical understanding of the needs of others. That these qualities are not peculiar to any particular social class in England can be seen from the enormous number of voluntary societies in England and, in particular, from the history of the trade unions, the cooperative movement and the Friendly Societies. I think Madariaga has laid his finger on a very important point when he stresses as a remarkable and

¹ Cf. the remarks of T. S. Eliot ((20), p. 352): "The admission of inconsistencies, sometimes ridiculed as indifference to logic and coherence, of which the English mind is often accused, may be largely the admission of inconsistencies inherent in life itself and of the impossibility of overcoming them by the imposition of a uniformity greater than life will bear." Cf. also the rather flattering account given by Madariaga ((10), p. 63).

typically English phenomenon which he calls "collaboration in opposition" (10), p. 22) and which he shows to be as important in the field of politics as in sport. With these qualities are associated also the capacity for collective deliberation, the toleration of divergent views and the considerateness shown to opponents, which are characteristic of so much of the social life of England. Social discipline is proved not to be incompatible with a respect for individual peculiarities and with freedom to criticize accepted and sanctioned views. The prestige of the law, for example, is not shaken in the least by the perpetual stream of satirical criticism directed against it. A French observer has said: "There is no country where the judges, i.e. the persons whose duty it is to administer the law, criticize it with more irony, or ridicule it with more humour, and that from the Bench, in the presence of the litigants" (17), p. 177). Equally illuminating is a comparison of the habits of debate or public discussion in England and other countries. I doubt whether any country excels England in the fundamental decency of public discussion, the urbanity and moderation which is shown to opponents and the care which is taken to keep out 'personalities' or imputation of bad motives to those from whom one happens to differ.¹ It remains to be added that these qualities which I have stressed as exhibited in the public life of England are not independent but closely interwoven. The empirical habit of mind harmonizes well with the attitude of tolerance and respect for other persons which is implicit in individualism. It is in the fusion of these qualities with the tendency to spontaneous association which gives distinctive character to English institutions.

Strangely enough, individualism is a quality which authorities both German and non-German have taken to be deeply rooted in the German character. A distinguished student of comparative religion, Otto Pfeiderer, finds in the history of German Protestantism ample proof of an extreme individualism, of a tendency of the personality to isolate itself at once from the outer world and the community and to seek in its own being the connexion with the divine (22). The older descriptions of social life in

¹ Of German debates Muller-Freienfels writes: "In hardly any other country of the world do political opponents so regard each other as moral scoundrels as in Germany, hardly anywhere else is political opposition so saturated with hatred as among ourselves. . . . Just as two German scholars who differ in their opinion regarding the value of the Niebelungen manuscripts invariably despise one another morally, so it is in the field of politics" ((7), p. 144). "In France", says Madariaga ((10), p. 158), "a debate is a battle and arguments are loaded. Every pair of eyes looks like the two barrels of a double-barrelled machine gun turning at high speed, throwing ideas at the enemy with the utmost alacrity. Arguments, innuendoes, accusations, insults are hurled through the air like projectiles."

Germany give a picture of people highly individual in their taste, unconventional, deliberately odd in their behaviour, blunt and rather brusque in their personal relations, stiff and reserved. In their political life this individualism is seen in a strong tendency to particularism and discord and an incapacity for wider unions except when they come under the influence of dominant leaders. Every German, said Bismarck, would rather have his own king. Their parliamentary history proves, as a recent commentator has pointed out, that every German would also like to have his own party. Their lack of political capacity seems to be the trait that has struck most observers. The individualism of the Germans thus differs from that of the English in not being accompanied or balanced by the capacity for spontaneous organization but requiring evidently organization based rather on some form of subordination.

Another quality generally ascribed to the Germans is strength of will. This is seen in economic life in their industry and in scientific work in the persistent 'laboriositas' already noted by Leibniz. There seem, however, to be certain characteristics of their thought and feeling which colour alike their will and their individualism. On the cognitive side the German mind seems often lacking in concreteness. Though the German works with abstractions, these do not seem to be reached by analysis of sense experience but rather by a sweep of imagination or fantasy. A German writer has characterized this tendency in the words: "Die Eigenheit der deutschen Abstraktheit ist Begriffsphantastik" (7, p. 88). Their intellect is not inspired by a search for order and clarity. Their interest in system again is often not rooted in the need for order, not the product of a drive to classify and understand, but rather of an imaginative longing for grandiose architectural schemes. Hence an *esprit large et trouble* which with a certain profundity and comprehensiveness often combines a tendency to vagueness and obscurity. On the side of feeling the German writers speak of a depth and inner warmth (*Innigkeit, Wärme, Tiefe*), but they also point to a vagueness and indefiniteness which the non-German describes as sentimentality. This combination of cognitive and affective vagueness shapes the nature of the will which, though thorough and realistic in many ways, is also liable to be moved by vague and highly abstract ends. What the German calls his idealism, says Muller-Freienfels, is a devotion to fanciful abstractions. It is rooted in feeling and fantasy and tends to evade and even resist rational control or definition. No doubt this can be said also of other peoples, but it does seem to be true that Germans are more apt to be moved by large but vague ends, that their will, like their thought, is lacking in the sense

of proportion or measure which is found in the English and the French.¹

This account of the German as highly individualist and as led by vague and fanciful ideals, an account which has the authority not only of German writers but also of foreign observers, has of course to be brought into relation with another side of German life, with which at first it seems to stand in glaring contradiction. What of what is called German militarism, German docility, German thoroughness and attention to detail and method? Muller-Freienfels solves this problem by resorting to the mechanism of compensation and over-compensation. Afraid of the anarchy which his deep-rooted individualism would produce, the German is ready to accept the leadership of a strong personality; fearful of the conflicts which his powerful but indefinite strivings must generate, he has recourse to minute regulation and prescription of every detail of group life; aware of the dangers of his speculative fancy, he insists on exact method and painstaking investigation; to keep his feelings in check he cultivates hardness and reserve. These are all compensations, it is claimed, developed by the Germans in the course of a century-long struggle with their own nature, especially under the discipline inculcated under Prussian influence. The process of compensation on this view of the matter is largely unconscious and is by the Germans themselves regarded not as based on reasoned calculation of consequences but as irrational or suprarational. Hence what other people call militarism is not thought of as such by the Germans and what strikes others as slavish submissiveness is by them thought to be willing acceptance of constraint.

Muller-Freienfels appears to think that the traits of docility, thoroughness and discipline are secondary and not primary features of German character. It has, however, to be remembered that the notion of compensation is easy to invoke but hard to verify, and in any case, if the compensation is genuine it is likely to be deeply rooted in unconscious need, and consequently to be an integral element of character. Other writers give a different and perhaps more plausible account of the duality of the German character. Lacking in the power of spontaneous organization, which in the case of the English provides a balance to the forces

¹ Cf. Nietzsche's remark: "As everything loves its symbol, so the German loves the clouds and all that is obscure, evolving, crepuscular, damp and shrouded; it seems to him that everything uncertain, undeveloped and growing is 'deep'" ((5), p. 198). Contrast Chateaubriand (23): "Le ténébreux, l'embroussaillé, le vapoureux, le pénible me sont abominables."

of individualism, the Germans have only been able to achieve such unity as they have by authoritarian discipline. Realizing this need for regimentation they have consciously and unconsciously divided their lives into separate zones, a private zone of freedom and independence and a public zone of deliberate acceptance of constraint. Writing in 1893 Professor Richard M. Meyer tells us: "The German frequently sadly disregarded political liberty, because he knew his liberty of thought to be safe from attack" ((14), p. 241). Dr A. Loewe tells us in a recent work that "up to the present the German Philistine, even when most impressed by political authority, has always managed to maintain his personality in his own eyes. By a private interpretation of the universe he tried to give to the most banal life the consecration of supra-temporal freedom" ((21), p. 25). Now that the Totalitarian regime has invaded even the personal zone of life it remains to be seen whether the individualist tendencies will have sufficient strength to assert themselves. It is clear that, for whatever reasons, the need for authority is deeply rooted in German life and that the relationship of inferior and superior pervades all spheres of activity. A prolonged period of education in other forms of organization will therefore be necessary before Germans are led to abandon the forms of order resting on authority and hierarchical subordination.¹ The view is often advanced that towards the end of the last century and the beginning of this century the Germans underwent a radical change of character which turned them from a nation of thinkers and dreamers into a nation of cool and hard realists. It seems more probable that with certain changes of aims the fundamental characteristics have remained unaltered. Especially noteworthy is the persistence of vague and cloudy aspirations and the admiration for the demonic, the heroic and the like. German *Realpolitik* and *Machtpolitik* are in many ways realistic and pursue perfectly definite and concrete aims, but equally the appeal which they make is essentially romantic. The same combination of definite aims with appeal to myth and fantasy is to be observed in much of the propaganda of the Nazis.

III. THE FORMATION OF NATIONAL CHARACTER

Having given some examples of the character of nations as reflected in their collective life, I propose now to say something on the factors which contribute to its formation. This question has undoubtedly been

¹ This at any rate was the view of many German writers before the advent of Nazism. Cf. Muller-Freienfels ((7), p. 159).

greatly obscured by being entangled with the problem of race differences. I have discussed the relation between nation and race elsewhere (24, 25, 26), and here I desire to draw attention to some of the more important points.

(a) The mental characteristics of the racial elements which have entered into the composition of the European elements are entirely unknown, and to explain national traits by reference to them is to explain the obscure by the more obscure. It is to be noticed that in recent anthropological work it has been found necessary to break up the three principal units, Nordic, Alpine and Mediterranean, into numerous subdivisions. Thus, for example, v. Eickstedt has three subdivisions of the Nordic (27), Coon four types (28). The Alpine and Mediterranean groups are not in any sense unitary entities. The psychological descriptions that are given of these racial groups still lump them together, but it seems extremely unlikely that what is said of the mentality of any of these large aggregates can really apply to all its constituent groups.

(b) The theory that the existing distribution of racial traits is to be explained in terms of hypothetical pure races supposed to have intermingled in various proportions is coming to be abandoned by modern anthropologists.¹ If such pure races ever existed we certainly know nothing of their mental characters. The descriptions we have of the habits of Gauls and Teutons cannot be taken as descriptions of Alpines and Nordics, since by all accounts they were racially composite and the part played by race in the determination of *their* mental characters is just as complicated and insoluble as the part played by race in the formation of the character of the French and the Germans.

(c) There is a difficulty of a more general kind. It is the habit of those who explain national character in terms of race to refer highly complex institutions to specific innate tendencies. McDougall ((8), p. 223), for example, explains the prevalence of a centralized system of government in France mainly by the supposed intensity of the gregarious instinct in the Mediterranean and Alpine races. But from gregariousness to centralized government is surely a far cry. The evidence of all those who know the French character intimately is to suggest that the attitude of the French to the state is not that which would be expected from a spontaneous play of the social tendencies. Madariaga describes the state in France as something mechanical rather than organic. M. Paul Gaultier stresses the fundamental individualism of the French, their lack of discipline and social cohesion, and he even speaks of an instinctive opposition to the state ((30), p. 156). It is clear that if social institutions

¹ Cf. especially Morant (29).

are to be referred to underlying psychological causes, use will have to be made of much more complex constellations than the instincts, and it seems highly probable that from very similar instinctive equipment very different forms of social grouping may arise.

(d) Any theory of national character must of course be able to account not only for the relatively permanent traits, but also for the changes that undoubtedly occur. On the racial hypothesis such changes are to be explained as due to various forms of racial changes brought about by emigration, immigration, conquest and social selection inside communities. An examination of the problems thus raised would require a lengthy treatise, but it may be worth while to give some brief illustration of the fundamental issues. As an example of explanation in terms of racial change due to war and immigration I may quote McDougall's assertion that the decline of the Greeks from the heights reached by them in the time of Pericles reflected a change in their mental qualities due to racial substitution brought about by wars, the slave trade and later by successive invasions of Slavs from the north. He goes so far as to commit himself to the statement that the modern Greek people is "descended largely from Slav invaders and largely from the numerous and prolific slave population of the great age of Greece, but hardly at all from the men who made the greatness of that age" (8), p. 249). Such explanations seem to suffer from two main defects, namely, the lack of adequate anthropological evidence and a failure to attend to negative instances. In the case of the Greeks it is to be remarked that McDougall's categorical assertions are not borne out by recent anthropological studies. Statements about the physical character of 'the Greeks' in general are of little value. If comparison is to be made with the Greeks of antiquity, care must be obviously taken that the reference is to the inhabitants of the same localities. It appears from recent investigations that when this is done the continuity of living Greeks with their ancestors of the ancient world is more striking than the opposite. Professor Coon (28), p. 604) tells us that "If one refers to the inhabitants of Attica during the sixth century, or to the Spartans of Leonidas, then the changes in these localities have probably not been nearly as great as that between the Germans of Tacitus and the living South Germans." The explanation of cultural changes in terms of racial substitution thus rests in this case at any rate on slender foundations. Even more serious is the failure of such explanations to take into account negative instances, i.e. instances of significant cultural changes not accompanied by known racial changes. A case in point is that of the Romans. The periods of vigour from the

fourth to the last century B.C., and the later brilliance of the Italians during the period from the eleventh to the sixteenth centuries A.D., have frequently been ascribed to the infusion of fresh blood. This explanation, however, fails completely to account for the later decline in the sixteenth century and the revival in the nineteenth century.¹ In the case of the Risorgimento the explanation is to be found in political factors connected with the re-establishment of contacts with Western civilization resulting from the temporary incorporation into the Napoleonic empire. But, if so, may not the earlier successes also have been largely shaped by social and political factors?

The problem of the effects of race mixture presents great difficulties. It has been claimed on biological grounds that the blending of allied races results in an increase of constitutional vigour and in a greater variety and variability of innate qualities. This may well be true, but the importance of these changes for cultural change is not forthwith to be assumed. We have to distinguish between the effects of race mixture on the genetic constitution of the resulting blend of peoples, and the effects of cultural stimulus and variability. The forces at work cannot be clearly isolated, yet the numerous cases of important cultural changes due to culture contact unaccompanied by race mixture on a big scale should make us hesitate to stress the purely genetic changes. No one, for example, would question the enormous influence exerted upon the political structure of England by the Norman conquest, yet the invasion did not in any way modify the physical type of the English ((32), p. 82). Similarly, while the cultural effect of the Roman conquest on France was of decisive importance, the racial effect was negligible ((33), p. 157). An examination of the results of the contacts between European and non-European peoples is even more illuminating, since it at once becomes clear that the cultural effects are out of all proportion to the degree of racial admixture. It seems therefore highly probable that even in those cases where culture contact is accompanied by racial amalgamation the purely genetic effects of the mixture are not so important for the formation of national characteristics as the sociological effects of the stimulus due to contact with fresh elements of culture.

There remains the problem of the effects of social selection. By this is meant the influence exerted upon the genetic constitution of a people by the action of social forces. Thus for example long-continued differences in fertility between social groups may, if the groups differ in genetic qualities, result in a change in the character of the people as a whole due

¹ Cf. the detailed examination of the facts by Professor Toynbee ((31), pp. 16 seq.).

to the increasing recruitment of its population from the more fertile groups. Elaborate investigations have been conducted on these lines by the Anthro-po-sociologists (Ammon⁽³⁴⁾, de Lapouge⁽³⁵⁾ and others). They claim to have shown among other things that Europe has undergone a process of 'denordicization' (*Entnordung*). This is supposed to have occurred through military selection (the Nordics being fighters and therefore tending to be killed off); through religious persecution (e.g. the emigration of Protestants); through urban selection (the Nordics being restless and enterprising and therefore attracted to the towns where they fail to reproduce themselves). I do not propose to discuss this particular view here. The evidence is considered by many competent authorities as insufficient to justify the formulation of general laws. It seems that there really has occurred an increase in brachycephaly, but the causes of this increase are disputed and some regard it as at least in part an environmental effect analogous to and accompanying the parallel increase in stature (⁽³³⁾, p. 278, ⁽²⁸⁾, pp. 10-11). In any case so far no one has succeeded in establishing any definite relation between broad-headedness and any mental quality, and the psychological effects of the increase in broad-headedness remains a matter of speculation. Another case frequently cited in this connexion is that of Spain, whose decline is attributed to negative selection resulting on the one hand from religious persecution, which killed off or drove out of the country individuals of independent mind and will, and, on the other, from the excessive multiplication of monastic orders which made celibates of large numbers of people presumably of superior ability. This argument suggested by Galton (⁽³⁶⁾, p. 344) was elaborated more fully by Fouillée (⁽⁴⁾, pp. 158 seq.). The biological effects of clerical celibacy must be a matter of doubt, since many of the priests were only celibates in name and since there is no proof that the majority of the priests differed from the rest of the population in innate independence or ability. Fouillée himself doubts whether the biological effects of celibacy, even if combined with the graver influence of the persecutions and expulsions, could have been such as to produce a really vital change in the quality of the population. He lays greater stress on the wars of Charles V and particularly the American conquests which drained Spain of men endowed with energy and the spirit of enterprise, and he explains that to these biological factors must be added economic and moral causes which he discusses at length. Apart from these rather speculative arguments there is a certain amount of direct evidence of the selective action of immigration. It has been shown for example that the Poles who came to the

United States during the nineteenth century and the beginning of the twentieth century differed in height, pigmentation and head-form from their own relatives who remained at home (28), p. 8), and that they did not represent a cross section of the entire Polish population. It does not follow, of course, that this selective immigration seriously altered the innate constitution of the Poles who remained in Poland.

It has also been alleged that the wholesale emigration from Ireland and Sweden to America has permanently affected the genetic constitution of these countries, but, so far as I know, there is no direct evidence of this change. The effects of urban selection have been studied in many countries since the question was raised by the Anthro-po-sociologists, without however any stress on the racial aspect of the process.¹ Though none of these investigations are conclusive, it is highly probable that over long periods of time social forces may act selectively on the genetic constitution of a people, and conversely the genetic constitution may in turn influence the forms of social life. Yet even a little reflection is sufficient to show that the processes involved in social change differ radically from those involved in racial change and that vast changes can be brought about in society without parallel change in the inherited constitution.² To begin with what is acquired by one generation can be transmitted to the next without resort to the genetic mechanism of inheritance. This makes possible cumulative change on a vast scale. Further, there is not the same need for continuity as in genetic transmission, since even ideas which have been forgotten may again be revived after a long interval of time and exercise renewed influence. Furthermore, co-operative division of labour renders it possible for societies to achieve results amounting to specific changes without any change whatever in the genetic constitution of the component members. For these and many other reasons racial change and social change appear to differ radically in their nature, and it is not to be expected that they should follow parallel courses.

These considerations have an important bearing on the problem of social selection. A sort of selection is operative in society which has nothing to do with the substitution of one genetic type for another. This may be shown by a few examples. It has been argued by Pirenne(38) that each of the phases in the growth of capitalism in Western Europe was initiated by 'new men' who made their way by exceptional audacity and vigour. Is there any reason to believe that these men were 'muta-

¹ Cf. Coon(28), p. 8 for references.

² This was clearly pointed out by Huxley(37).

tions' suddenly called into being by the circumstances of the time? It is surely far more likely that these qualities were always present in the population and that sections of it which hitherto were denied opportunity were able to seize it by a change in the social conditions affecting commerce. Similarly present-day Germany is ruled by a group of people of distinctive mentality, but they are hardly likely to be a fresh biological product. In different circumstances quite a different group may attain predominance and thus present to the world quite a different aspect of the German character. In short, the selection exercised by social forces need not operate by way of biological elimination or substitution. It operates rather by encouraging or inhibiting the expression of certain qualities and by determining their direction or mode of manifestation. A totalitarian regime may drive individuals of a certain endowment out of the country, and this may have some effect on the biological constitution of the stock. But in the main the hereditary qualities of peoples may well remain constant while changing circumstances bring different sides of the underlying character into play or give dominance to different elements of the population at different times. The process of adaptation is thus social rather than racial and, if the term 'selection' is to be used at all in this context, it must be given a meaning very different from that which it has in biology.

In summing up these arguments we must, I think, distinguish between genetic qualities in general and those which are claimed to be racial traits. Since at present very little is known of the mental characteristics of races, we can obviously make very little use of them in accounting for national characteristics. But this is not to say that genetic qualities do not count. Unless we are prepared to deny the inheritance of mental characteristics we must regard it as highly probable that just as there are individual differences there are also group differences and that these play their part in shaping the collective life of groups. The difficulty is to determine exactly what their role is. The inherited constitution must in some sense put a limit to what can be achieved by social organization. If the latter puts too high a demand on the character of individuals, it will not work, and, if a movement is forced by enthusiasts on a reluctant mass, it may come up against ineluctable predispositions which will in the end defeat it. Yet here again it must be remembered that the range of human potentialities is extraordinarily wide and that upon the same hereditary elements very different social structures may be built. There seems no warrant for assuming any such differences between national groups as would amount to an inherited incapacity of anyone for the

arts and institutions achieved by another. We cannot infer from the incapacity hitherto displayed by any people to run democratic institutions that they must forever remain so incapable. If then there is an inherited element in the character of nations of long standing they nevertheless retain considerable powers of adaptation and the limits of these powers cannot be determined with any accuracy from their previous history.

In view of the above considerations it would seem that the differences in the character of the European peoples are not in the main to be traced to variations in innate tendencies, but rather to variations in the ways in which these are expressed, balanced and directed. Even in referring to highly complex qualities of character like 'individualism', 'empiricism', 'collaboration in opposition', we cannot say that these qualities are either present or absent in a given people. There is, for example, a French individualism, an English individualism, and a German individualism. So again different peoples may successfully work the same institutions—but with a difference. To account for these differences we have to look to historical and social conditions and only in the last resort should we appeal to genetic variations. If for example we seek to ascertain the conditions which have given a definite tinge to the behaviour of British diplomacy, we have no need to appeal to unverifiable genetic factors. Far more illuminating is the attempt made by such writers as Bardoux⁽³⁹⁾ and Kantorowicz⁽¹⁾ to analyse the historical conditions in which that behaviour has taken shape, e.g. the geographical conditions which have given to British diplomacy a certain constancy of aim, the peculiarities of the English class structure which has put the conduct of foreign affairs in the hands of a class with special codes of behaviour, the feeling of security and confidence generated by the absence of the fear of war and fear of revolution which has formed the background of continental diplomacy. So again the peculiarities of the political individualism of the English are not traced with any probability to the supposed inborn qualities of the Saxon peasant. They are surely connected rather with the special conditions which prevented the growth of a centralized administration and encouraged the growth of local government, and of a legal system serving to protect the liberties of the individual.¹ In a certain sense no doubt the institutions of a people express

¹ In a recent work⁽⁴⁰⁾, Profs. Buckland and McNair show the remarkable similarities that exist between the practical rules of the Roman Law and the Common Law, despite the difference in the fundamental conceptions on which the two systems rest. They attribute the similarity to a certain resemblance in the habits, the morale, the *Anschauungen* of the two nations and the difference in the conceptions to a difference in racial origin. It is difficult to see how such a hypothesis could ever be put to the test.

in the long run the character of the people, but equally the character is formed by the institutions. The congruence of the different aspects of a nation's life in particular depends on the unity and continuity of its historical development. It has been remarked, for example, that in this respect there is a profound difference between England and Germany. In England there is a certain homogeneity of texture in the various manifestations of the national life, while in Germany religion, government and philosophy seem rather to diverge in their development. The explanation is surely that in England the early attainment of political unity facilitated the interaction of the various elements of the national life, while in Germany the conditions favoured the perpetuation not only of marked local variations but of more rigid distinctions between professions and social classes.¹

I will now try to sum up briefly the general conclusions which emerge from the above survey. First, the study of national character is to be approached not through an investigation of individual differences in behaviour, but of the qualities manifested in the collective life of nations, their traditions and public policy. Secondly, the object of this study is to discover whether these manifestations of the collective life reveal the existence of relatively permanent and stable traits and dispositions and how far these form congruent systems. Thirdly, such studies as have so far been made indicate that although ultimately national character must be linked with the genetic qualities of the stock, these are highly plastic and susceptible of wide variation in their actual expression. Hence the national character is not something given once and for all, but something always in the making, moulding and being moulded by the circumstances in which nations find themselves.

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¹ Cf. E. Barker(41), p. 235, and Dibelius(3), p. 154.

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PERCEPTION DURING DARK ADAPTATION

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From the Cambridge Psychological Laboratory

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I. INTRODUCTION

It is a well-known fact that individuals differ in their ability to 'see in the dark', a fact that becomes of great importance during the 'black-out'. It has generally been assumed that differences in this ability were dependent on differences in the absolute threshold of vision, and its modification during dark adaptation. But 'ability to see in the dark' means in effect 'ability to perceive in the dark'; and it has never been shown that the variation of perceptual ability during dark adaptation is a function of the variation in the absolute threshold and of this alone. In fact, it seems probable that other factors are operative in determining perceptual ability during dark adaptation. And therefore it is a matter of some interest and importance to discover the nature of these factors.

In consequence, series of experiments were designed to measure, first, the changes in the absolute threshold of vision for various individuals during a fairly long period of dark adaptation; and, secondly, the changes in perceptual ability of the same individuals during a corresponding period. Now it seemed probable that 'perceptual ability' is not one indivisible entity functioning regardless of the nature of the material to be perceived, or of the situation in which it is perceived. Consequently the following varieties of perceptual material and situation were em-

ployed, in the hope that they might afford some idea of the possible variations of perceptual ability according to material and situation:

(1) A very simple perceptual task: The subject was required to report the orientation of a white dial hand on a black background.

(2) More complicated perceptual material, allowing much greater freedom of interpretation: The subject was presented with a series of meaningful silhouette pictures, black on a white ground, and required to report what he saw.

(3) Simple perceptual material combined with a simple motor task: The subject was required to trace with a stylus a simple white maze pattern on a black background.

Since the acuity in fully dark-adapted vision is low, and only large objects, simple outlines and strong brightness contrasts are visible, it was necessary to present fairly large, boldly designed black and white forms such as those described.

A further point arises in connexion with individual differences in the absolute threshold of vision during dark adaptation. It has usually been assumed that if one individual can see much better than another immediately after coming out from a brightly lighted room into the dark street, then the same individual will also see much better than the other after being in darkness for a long period of time. Now the ability to see in the dark for a short period after the eye has been bright adapted has been shown by Hecht (1921), Kohlrausch (1922), and Hecht, Haig & Chase (1937) to be a function of cone vision entirely. But the amount which the cones can dark adapt is limited, and becomes complete after 5-10 min. in darkness even when the eye has previously been completely adapted to illuminations of very high intensity (sooner, of course, after partial light adaptation). If, however, the individual is not in complete darkness, or is frequently exposed to lights of moderate intensity, he will continue to make use of cone vision over longer periods. But if he remains in darkness, with his eyes exposed to an illumination of less than about $\frac{1}{500}$ e.f.c., he will make use of rod vision, which continues to adapt over a longer period in darkness, and does not become even approximately constant in threshold value until after 30 min. in darkness, if the eye was previously completely light adapted. Thus it may be that certain individuals have relatively low absolute thresholds in cone vision, and can therefore see fairly well just after coming out of a light room, or in moderately dim light; but they may be relatively poor in their ability to see after long periods in the dark because their absolute thresholds in fully dark-adapted rod vision are relatively high. Or the opposite con-

dition may occur. Thus it seemed to be important to measure both absolute threshold for vision and perceptual ability more or less continuously over a longish period of time, in order to determine whether such differences existed.

II. METHOD OF EXPERIMENT

Series I. In the first series of experiments continuous determinations were made of the absolute threshold for vision during dark adaptation over a period of 50–55 min. Dark adaptation was preceded by a 3 min. period of light adaptation to a 100 W. lamp seen binocularly in Maxwellian view,¹ giving a uniform brightness of 12,000 e.f.c. over a pupil area 2.2 mm. in diameter (56° of the retina). It has been shown by Craik & Vernon (1941) that the eyes were completely light adapted by this degree of brightness, and thus that all subjects began their period of dark adaptation in a similar state of adaptation whatever their exposure to light or darkness previous to the light adaptation.

The essential features of the apparatus used in the first series of experiments were the light-adaptation apparatus and the projector apparatus which projected a light patch on to a white screen; the brightness of the patch could be adjusted continuously by the subject to threshold intensity.

The light adaptation apparatus consisted of a metal box containing the 100 W. lamp at the farther end. This was observed binocularly through adjustable condenser lenses which gave the Maxwellian view. Infra-red radiation was cut out by a calorex filter. At the close of the period of light adaptation, the box was swung rapidly out of the field, and a pair of artificial pupils, 2.2 mm. in diameter, rigidly connected with the box, were swung in front of the subject's eyes. Through these he viewed the test patch on the screen. The position of the lenses, the pupils and the chin rest was correctly adjusted before light adaptation began.

The projector apparatus consisted of a 3 W. bulb in a light-tight box with condenser and objective in a focusing mount. The test patch was 5 in. in diameter, on a screen 50 in. from the subject; the visual angle was therefore $5^\circ 43'$. The maximum brightness of the test patch was 0.27 f.c.; the brightness at the eye, 0.22 e.f.c. A neutral gelatine wedge filter could be moved across the light objective by means of a rack and pinion arrangement, in order to vary the brightness of the test patch. A pencil fastened to the frame of the filter traced on a clockwork drum which made one complete revolution per hour. A continuous tracing was thus obtained of the variations in

¹ In the Maxwellian view the pupil and the light source are placed at conjugate foci of the lens. The eye, being near the lens, has cast upon it a much reduced image of the light source, and this acts as an artificial pupil limiting the area of the retina stimulated. A uniformly illuminated field of light is perceived.

position of the filter, and hence of the brightness of the test patch, over a period of almost 1 hr. The thickness of the wedge, and hence the light intensity, varied on a logarithmic scale, over 6 log units; and a fall in the traced curve of 1 in. corresponded to a ten-fold decrease in intensity.

The subject was instructed to adjust the brightness of the test patch continuously so that it always appeared to him just visible but no more. To help him in locating the test patch, which at threshold intensity was rather easy to lose, a fixation point was provided at the centre of the test patch. This consisted of a blue flash lamp bulb placed behind the screen and shining through a hole in it. Its intensity could also be adjusted by the subject so that it was slightly, but not greatly, brighter than the test patch.

Further details as to apparatus and its calibration are given elsewhere (Craik & Vernon, 1941).

The subjects of the experiment were sixteen adults, thirteen male and three female, aged 20-40. All but one had had a University education, and all were experienced in experimental work.

Series II. In Series II, the procedure during light adaptation and during the first 10 min. of dark adaptation was the same as the procedure in Series I. The diameter of the test patch was now $9\frac{1}{2}$ in. ($10^{\circ} 45'$). After 10 min. dark adaptation, the test-patch light was extinguished, and on the white screen was placed a piece of black cardboard, 10 in. square, with a white dial hand, $4\frac{1}{2}$ in. long by $\frac{1}{2}$ in. wide, rotating about its centre (see Fig. 1*a*). The light was switched on again, and the subject instructed to increase its intensity until he could perceive the dial hand and report its position in terms of the hour hand of a clock. White patches on the four sides of the square enabled the subject to orientate his perception of the dial hand; but the latter was never set to coincide with any one of the patches.

Eight readings of the dial hand were made. Again after 20 and 40 min. dark adaptation further sets of eight readings were made. Between making these readings, the subject continued adjusting the test-patch brightness to the absolute threshold. Fifteen of the same subjects carried out this series of experiments, together with two additional subjects who had not had a University education nor any training in experimental work.

Series III. In this series the procedure during the light adaptation and during the first 10 min. of dark adaptation was as in Series II. The test-patch light was then switched out, and a black and white silhouette picture, 10 in. square, placed on the white screen (a specimen is shown in Fig. 1*b*). The experimenter then moved the filter back through 0.5 in. in order to increase the intensity of the test-patch light by 0.5 log units above threshold (about three-fold). The light was switched on for 2 sec. and the subject required to report what he saw. The filter was then moved back a further 0.5 in. (a total increase of ten-fold), and a further 2 sec. exposure given. The light was then turned on and the subject allowed to view the silhouette at his leisure. Finally, if he was still unable to perceive it at all correctly, he was instructed to increase the light intensity until he could do so.

A silhouette was presented to the subject every 5 min. from 10 to 45 min. after the beginning of dark adaptation, the above procedure being repeated each time. In between presentations the subject continued to adjust the test patch light to the absolute threshold. The subjects were the same as in Series II.

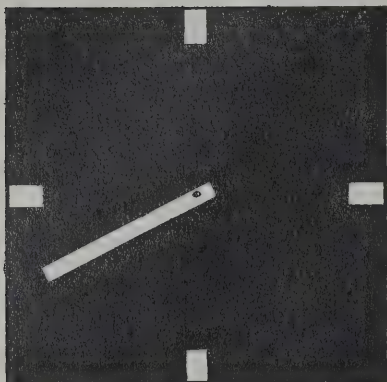


Fig. 1 a.

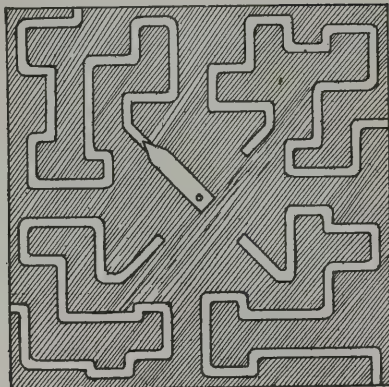


Fig. 1 c.



Fig. 1 b.

Series IV. In this series the intensity of the light during light adaptation was 8000 e.f.c. It has been shown by Craik & Vernon (1941) that the eye is so nearly completely light adapted by a light of this intensity that the form of the subsequent dark adaptation curve is almost identical with that obtained after adaptation to a light of 12,000 e.f.c. After light adaptation the subject was seated in the dark 2 ft. from a vertical blackened metal plate, 20 in. square, which he observed binocularly and without artificial pupils by the light of two flash-lamp bulbs shining through pin-hole apertures, placed behind and on either side of him. On the four quadrants of the plate were pasted four white paper maze patterns (see Fig. 1c); and in the centre was a white pointer which could be set to point to any one of the patterns. The intensity of illumination of these was 0.0007 f.c., giving a brightness at the eye of 0.0005 e.f.c. At first the patterns were invisible to the subject, but they appeared gradually, and after a period of 7–20 min. he could see the pointer. He was instructed that as soon as he could do so he should report its direction, and, if he did this correctly, begin to trace out the corresponding maze pattern with a metal stylus. If he allowed the stylus to slide off the pattern on to the metal plate, electric contact was made, which was recorded on an electrically operated drum. A time marker also recorded on the drum, and a signal, operated by the experimenter, at the beginning and the end of the maze tracing. The tip of the stylus was coated with radium paint, so that it was faintly but not clearly visible to the dark-adapted eye. As soon as the subject finished the first maze, the pointer was reset, and 3 min. after the commencement of the first maze he was required to begin the second. The third and fourth mazes were begun 6 and 9 min. respectively after the beginning of the first maze.

The subjects were the same as before.

III. RESULTS OF EXPERIMENTS

(1) *Series I*

The curves for the decrease with dark adaptation of the absolute threshold for vision all show the same general form which is indicated in Fig. 2 (p. 213). During the first period when the curve falls rapidly cone adaptation was taking place. After that there was a stationary stage, or even a rise of threshold, until rod adaptation began. The latter was a less rapid process, coming gradually to a standstill. The greater part of it was complete after about 30 min. in the dark, but, at least in certain individuals (e.g. Subject A, Fig. 2), still continued at a slow rate up till the end of the 55 min. period.

There were considerable individual variations in the rate of fall of the curve; in the absolute thresholds for fully dark-adapted cone and rod vision; and in the period of time until rod adaptation began to appear. The final cone and rod thresholds for the different subjects are given in Table 1, together with the time until the commencement of rod adaptation; and typical curves for four subjects are shown in Fig. 2. For

clearness of presentation these have been 'smoothed' from the original tracings, but examples of parts of the latter are given in Fig. 3. Subject D in Fig. 2 had a very low cone threshold, attained very rapidly; and rod adaptation began after 5 min. Subject A had a rather high cone threshold, and rod adaptation did not begin until after 10 min. But the rod threshold fell rapidly, and reached the same level as Subject D's after 30 min.,

Table 1

Subject	Intensity in log units of		Com- mencement of rod adaptation in min.	Subject	Intensity in log units of		Com- mencement of rod adaptation in min.
	Final cone threshold	Final rod threshold			Final cone threshold	Final rod threshold	
A	-2.1	-4.7	11	I	-2.4	-4.1	9
B	-2.7	-4.6	4	J	-2.4	-4.0	9
C	-2.1	-4.5	8	K	-2.2	-3.8	6
D	-2.9	-4.5	5	L	-2.0	-3.8	10
E	-2.6	-4.2	8	M	-2.2	-3.7	10
F	-2.3	-4.2	8	N	-2.0	-3.65	12
G	-2.3	-4.2	12	O	-1.5	-3.6	6.5
H	-2.3	-4.2	8	P	-2.2	-3.2	17

and finally a lower level than Subject D's. The cone threshold of Subject P was almost the same as that of Subject A, but he was very slow in reaching the beginning of rod adaptation, and his final rod threshold was far higher than A's. Subject O's cone threshold was much higher than that of any other subject in the series;¹ but his rod adaptation began quickly, after 6 min., and his final rod threshold was considerably lower than Subject P's. Thus Subject A showed a great capacity for rod adaptation, covering 2.6 log units (about 400-fold); while Subject P showed a very small capacity, covering only 1.0 log units, or ten-fold. Subjects D and O were intermediate in range. And Subjects D and P would tend to 'see in the dark' relatively better immediately after coming out of the light; while Subjects A and O would do relatively better after a long period of time in the dark. But Subject O would never reach the capacity of Subjects A and D to 'see in the dark'. Consequently in estimating the ability to 'see in the dark' it is necessary to take into account the exact situation in which 'seeing in the dark' is to take place.

When the actual tracings of the threshold readings are studied, a further characteristic difference between subjects appears. The subject was instructed at the beginning of the experiment that the brightness of the test patch might seem to fluctuate, so that the test patch might

¹ Actually Subject O's cone threshold was rather variable; but Subject L gave an example of a consistently high cone threshold (see Fig. 4).

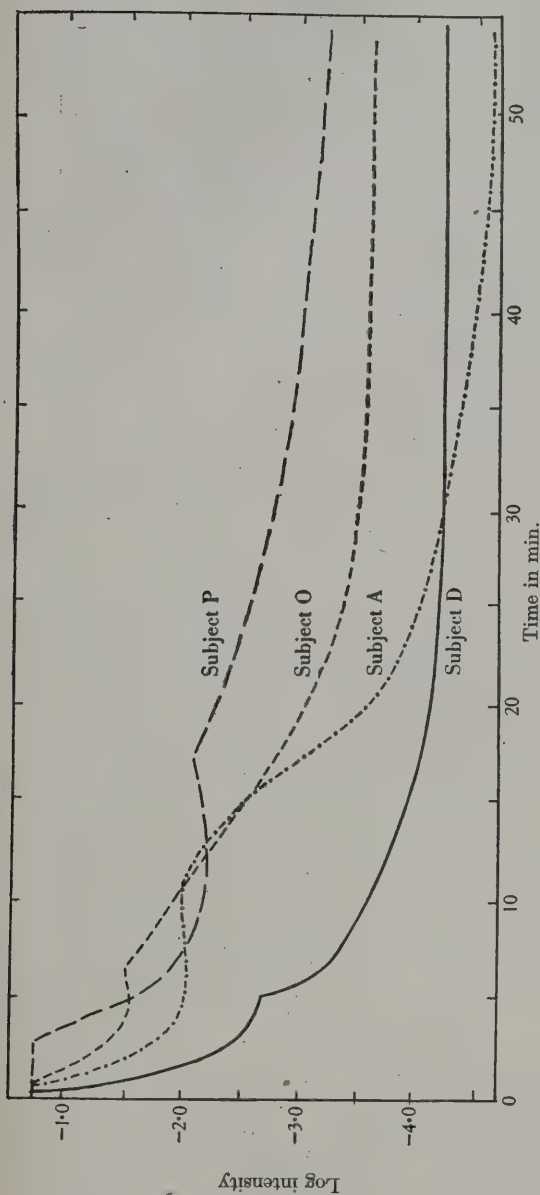


Fig. 2. Individual dark adaptation curves.

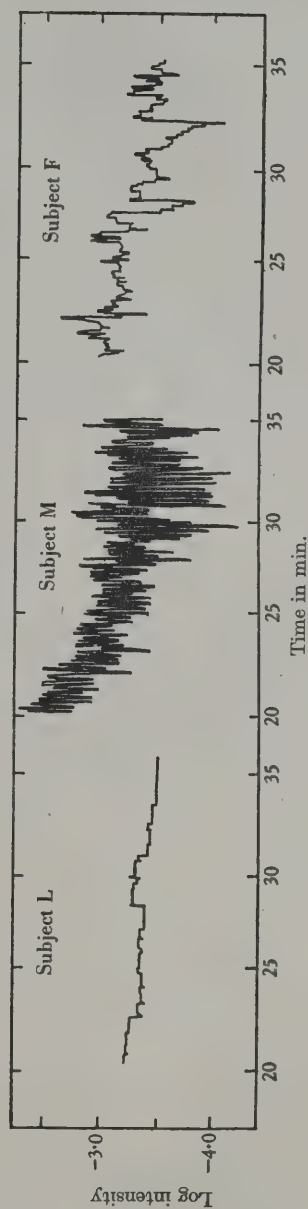


Fig. 3. Individual variations in dark adaptation (unsmoothed) curves.

perhaps disappear altogether, and in consequence if he wished he might bring it back into view by increasing the illumination. Some subjects made little use of this permission, others a great deal. Thus some curves were relatively smooth, while others showed constant fluctuation. Moreover, the fluctuations were greater in extent in the latter than in the former. Portions of three such curves given by Subjects L, M and F are shown in Fig. 3. Now it would appear that in perception Subject L might do much better or much worse than Subjects M and F according as a momentary glance or a steadily maintained scrutiny was required. We shall show below that something of the kind did appear in the perceptual experiments; and that an underlying temperamental difference seemed to account for these differences in fluctuation, and for the corresponding differences in perceptual ability.

(2) *Series II and III*

From the results of Series II two curves were obtained for each subject, one for the absolute threshold of vision and one from the points at which the dial hand was perceived. The curve for the absolute threshold was also obtained in Series III, but not for the points at which the silhouettes were perceived, since these were presented at intensities bearing a fixed ratio (3 and 10 times) to that of the absolute threshold. Another method of scoring perceptual ability was therefore adopted, which will be described below.

It is interesting in the first place to compare the final absolute threshold for rod and cone vision in Series I, II and III. The use of the larger test patch in Series II and III resulted in a lower final rod threshold; this effect was produced presumably by summation in rod vision. But the thresholds for the three series showed a fairly close parallelism.¹ The final cone and rod thresholds for Series II and III are given in Table 2, and in Fig. 4 they are plotted against the corresponding values for Series I. The chief discrepancies are shown by Subjects F and G, and to a less degree by B and Q. It was quite clear from their behaviour that F and G were erratic subjects, who easily became bored and inattentive under the rather monotonous conditions of the threshold experiments. Series II and III provided more variety than did Series I, and stimulated them to

¹ The degree of correspondence between these and subsequent sets of values for the different subjects might be measured by correlating them. But such a measure would indicate little. The number of subjects is too small to deduce any general trends from their results; and individual differences would be obscured, whereas they are revealed by comparison of the curves.

work more accurately. The type of curve reproduced for Subject F in Fig. 3 seems to be characteristic of such an observer; it shows a constant unsteady fluctuation, though without the almost obsessive to-and-fro movement of Subject M's. It seemed probable that B also was rather inattentive, though not restless and bored. Q was an inexperienced and untrained subject, and it is probable that in Series II, the first he performed, he kept the test patch well above the threshold intensity, but reduced it somewhat in Series III. Confirmatory evidence of this point will be given below. It may be concluded, however, that the majority

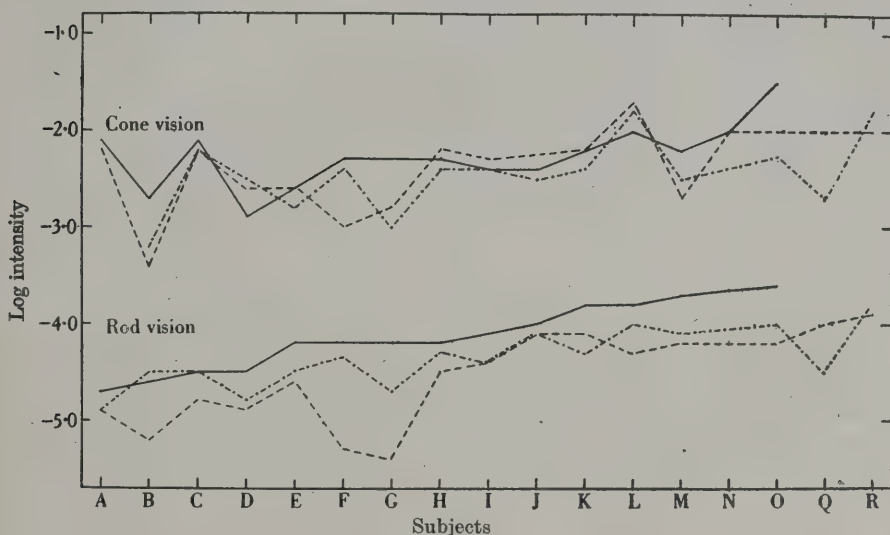


Fig. 4. Final absolute thresholds in cone and rod vision.

— Series I. - - - Series II. - · - Series III.

of individuals will give fairly consistent and reliable results in an absolute threshold experiment. But there will also be certain individuals who are not reliable; and lack of training and tendency to feel boredom may decrease reliability.

More important, of course, is the relationship between the perception of form and the absolute threshold of vision. In Table 3 are given the average intensities at which the dial hand was perceived during the periods beginning 10 and 40 min. after the commencement of dark adaptation; and the corresponding average absolute thresholds during those periods. The same results are plotted in Fig. 5. Here the correspondence is extremely close during the first period in which mainly cone

vision was employed—for perception of the dial hand almost entirely. This is rather to be expected, since during this period acuity was fairly high, and so there was little necessity for using the interpretation from faint visual cues which we shall find to be so important in certain types of perception. The correspondence is rather less striking during the

Table 2

Subject*	Series II		Series III	
	Final cone threshold	Final rod threshold	Final cone threshold	Final rod threshold
A	-2.2	-4.9	—	-4.9
B	-3.4	-5.2	-3.2	-4.5
C	-2.2	-4.8	-2.2	-4.5
D	-2.6	-4.9	-2.5	-4.8
E	-2.6	-4.6	-2.7	-4.5
F	-3.0	-5.3	-2.4	-4.35
G	-2.8	-5.4	-3.0	-4.7
H	-2.2	-4.5	-2.4	-4.3
I	-2.3	-4.4	-2.4	-4.4
J	—	-4.1	-2.5	-4.1
K	-2.2	-4.1	-2.4	-4.4
L	-1.7	-4.3	-1.8	-4.0
M	-2.7	-4.2	-2.5	-4.1
N	-2.0	-4.2	—	—
O	-2.0	-4.2	-2.25	-4.0
Q	-2.0	-4.0	-2.7	-4.5
R	-2.0	-3.9	-1.8	-3.8

* Certain subjects, or certain of their results, are omitted from this or subsequent tables, because they were unable to perform the series, or because the record of their performance was imperfect.

Table 3

Subject	After 10 min. dark adaptation			After 40 min. dark adaptation		
	Av. intensity for perceiving dial hand	Av. absolute threshold of vision	Difference	Av. intensity for perceiving dial hand	Av. absolute threshold of vision	Difference
A	-1.9	-2.7	0.8	-3.7	-4.7	1.0
B	-3.9	-4.45	0.55	-4.4	-5.2	0.8
C	-2.7	-3.2	0.5	-4.0	-4.85	0.85
D	-1.8	-2.9	1.1	-3.4	-4.85	1.45
E	-2.5	-3.05	0.55	-3.7	-4.5	0.8
F	-3.2	-3.8	0.6	-4.0	-5.25	1.25
G	-3.05	-3.55	0.5	-3.9	-5.1	1.2
H	-2.4	-3.15	0.75	-3.7	-4.6	0.9
I	-2.4	-3.05	0.65	-3.7	-4.35	0.65
K	-1.9	-2.75	0.85	-3.1	-4.1	1.0
L	-1.8	-2.4	0.6	-3.5	-4.3	0.8
M	-2.2	-2.8	0.6	-3.3	-4.2	0.9
N	-1.8	-2.3	0.5	-3.1	-4.05	0.95
O	-2.6	-3.35	0.75	-3.1	-4.2	1.1
Q	-2.1	-2.4	0.3	-3.7	-4.0	0.3
R	-2.0	-2.45	0.45	-3.7	-3.8	0.1

second period, though it is still fairly close. Subjects D, Q and R are somewhat anomalous. In the case of Subject D, this discrepancy was due to his very considerable refractive errors (his vision was -2.75 D. for the right eye, -11.5 D. for the left), which greatly reduced his ability to perceive forms under the conditions of these experiments. As mentioned above, Subjects Q and R were inexperienced, and for this reason kept the test patch at an illumination well above threshold during absolute threshold measurements; hence the intensity of the latter was very little lower than that of the dial hand readings. But we may conclude that in

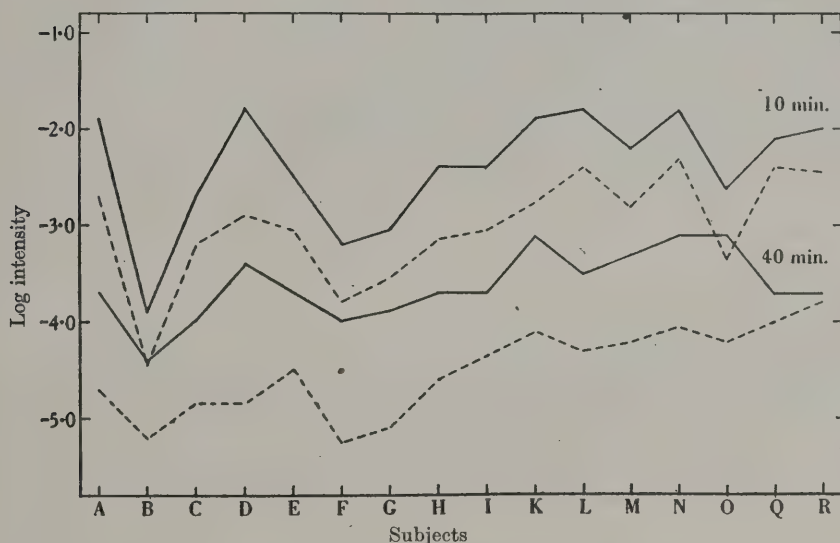


Fig. 5. Average intensity for perception of dial hand and average absolute threshold 10 and 40 min. after beginning of dark adaptation. — Perception of dial hand. - - - Absolute threshold.

general the ability to perceive in dim illumination such a simple type of object as a white dial hand on a black background is mainly a function of the absolute threshold for vision under corresponding conditions.

But in perceiving such an object, the 'degrees of freedom' possessed by the observer are few. He knows exactly what type of form he will be required to perceive, and that its only variation will be its rotation round a circle. But in the perception of other forms the possible variations are much more numerous, since their size and shape may be quite unknown beforehand to the subject. If a collection of real objects is presented, he must not only perceive their shape—he must in addition recognize

what they are. Now in very dim light, the intensity of which is below the threshold for cone vision (about $\frac{1}{500}$ e.f.c.), it is impossible to make out any detail of the form of an object, since the acuity of rod vision is too low (Marshall, 1939). Thus the observer will get no more than a vague impression of the shapes of objects. In the same way, if he is shown meaningful pictures, he will see only general contours and strong brightness contrasts. From these he must not only gain some general idea of the shapes depicted, but must also give these a meaningful interpretation, and must recognize what the pictures are intended to represent. It is possible that the perception of objects, and the abilities required for it, may differ in nature from the perception of pictures. But the sensory data involved in the two types of perception are much more similar in dim than in bright light, since only general impressions, without any detail (or, probably, any impression of depth and solidity, in the case of solid objects), can be gained in either case. Consequently in both cases the observer is obliged to fill out the vague sensory cues and interpret them in accordance with any previous knowledge he possesses, any anticipation of what is likely to be seen, and any internal consistency in the picture itself.

Thus it is natural to expect that the ability to perceive objects or meaningful pictures will not be determined wholly, or even mainly, by the absolute threshold of vision. And therefore Series III, consisting of meaningful silhouette pictures, was presented in the hope that it might throw some light on the other important factors in the process. Now it was not possible to proceed as in Series II and allow the subject to increase the illumination until he could say what the pictures were. The point at issue was to determine the lowest intensity at which it was possible to make a reasonably accurate guess at the meaning of the picture. Left to himself to increase the intensity, the subject would usually increase it until details of the pictures were fully visible, before making his report. Consequently the subject was first of all required to say what he thought the picture represented when the latter was exposed at an intensity of three, and then ten, times the visual threshold; first for a short, 2 sec. exposure, and after for a long exposure. Finally, if he still had no idea what the picture was, he was allowed to increase the intensity until he could make it out.

It appeared immediately that the subject was frequently able to get a very good idea of what the pictures represented even when the illumination was very dim, i.e. below the cone threshold. If, however, he was for any reason unable to make this sort of guess, but required to see

further detail in order to make out the picture, he was obliged to increase the intensity above the cone vision threshold. That is to say, although rod vision possessed an acuity too low to allow any accurate perception of detail, it did enable the subject to make out the general nature of the picture, provided he could fill out the vague sensory cues from some sort of idea as to what they indicated. It was most striking to note the accuracy of these interpretations in view of the vagueness and uncertainty of the actual sensory impressions which the subjects reported. Some idea of the way in which decisions were taken about vague perceptual impressions is given by the following reports:

"A man walking up hill and an animal in front of him—awkward and strained position—so peculiar he mightn't have been a man."

(First report): "A series of what looked like pillars." (Second report): "Four objects; the highest has a sharp peak to it, might be a spire; the other ones square, might be houses."

"A man with two either dogs or sheep. Looked as if he might be holding on to one, therefore presumably it was a dog."

It was also possible to measure the least intensity at which these pictures could be perceived from the lowest intensity at which any one of the silhouettes was accurately perceived. Another measure was given by the lowest intensity at which any one of the silhouettes was partially perceived, i.e. the subject had a general idea as to the type of object or

Table 4

Subject	Final rod threshold	Lowest intensity at which silhouettes were perceived		Av. intensity for perceiving silhouettes in cone vision
		Partially*	Wholly*	
A	-4.9	-3.9	-3.9	—
B	-4.5	-3.25	-2.95	-2.3
C	-4.5	-3.5	-3.15	-2.1
D	-4.8	-2.35	-2.05	-1.5
E	-4.5	-3.4	-3.4	-2.3
F	-4.35	-3.8	-3.05	-1.8
G	-4.7	-3.6	-3.0	-2.6
H	-4.3	-3.2	-3.0	-1.7
I	-4.4	-3.85	-3.3	-1.9
J	-4.1	-3.35	-3.35	-2.1
K	-4.4	-3.8	-3.25	-1.9
L	-4.0	-3.35	-2.95	-1.7
M	-4.1	-3.05	-3.05	-2.4
O	-4.0	-2.95	-2.3	-1.5
Q	-4.5	-3.3	-3.3	-2.2
R	-3.8	-2.75	-2.1	-1.8

* When the figures under 'partially' and 'wholly' are identical, this indicates that the subject was able to perceive the silhouette 'partially' during the 2 sec. exposure at this intensity, and 'wholly' during the long exposure.

scene depicted, but could not report it accurately. These figures are given in Table 4, together with figures for the final rod thresholds in this Series; and are also plotted in Fig. 6; in descending order of absolute threshold. It is immediately clear that there are considerable discrepancies between the ability to perceive the silhouettes and the final rod threshold. It is true that on the whole those with lower rod thresholds are superior in perceptual ability to those with higher rod thresholds. But there is a smaller range of perceptual ability than of absolute

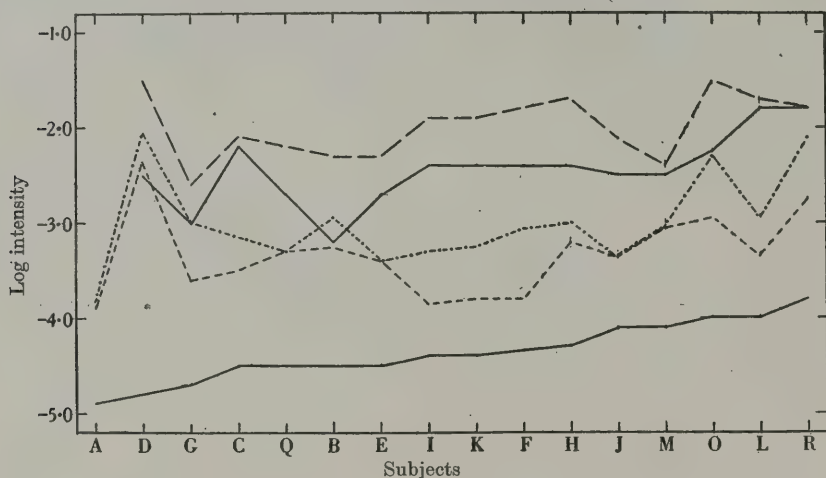


Fig. 6. Intensity for perception of silhouettes and absolute threshold. — Final cone and rod thresholds. — Average intensity at which silhouettes were accurately perceived in cone vision. - - - - Lowest intensity at which silhouettes were accurately perceived in rod vision. - · - · - Lowest intensity at which silhouettes were partially perceived in rod vision.

threshold; or, to put it another way, those with low rod thresholds are less superior in perceptual ability than they are in visual ability to those with high rod thresholds. This is probably due to the low visual acuity of dark adapted rod vision; thus in perception, which demands a certain degree of visual acuity, those with low rod thresholds do not obtain the full advantage of this quality.

But there are also individual variations. Subject D was conspicuously poor at perception; and this we have already mentioned as being due to his refractive errors. Minor refractive errors may have accounted in part for Subject O's poor perceptual ability; but we shall refer to him again below. Other subjects who were relatively poor at perception were B, G and R. Subjects B and R were quite definitely inferior both in intelligence

and in general education to the other subjects of the experiment; and they made relatively little attempt at an intelligent interpretation of the 'partial cues' afforded by the vague visual impressions. Thus for instance Subject R reported seeing 'some sort of tall structure like a spire', but made no further attempt at inferring that the picture might contain a church.

Subject G was conspicuously poor throughout Series III, although his score pulled up a little by an accurate perception of the last silhouette. He was one of those cautious and resistant individuals who hate to give themselves away or be caught napping and he refused to 'guess at' any of the possible interpretations. Subject H was also relatively bad at perception, though less so than those just mentioned. A biologist by profession, he adopted throughout a cautious scientific attitude towards interpretation of partial cues. His responses were brief and his guesses few, and he obviously did not wish to report anything for which he had no accurate evidence.

Similar attitudes were apparent among some of the subjects who could not partially perceive the pictures at an intensity any less than that at which they could perceive them accurately. These were Q, E, J and M. E's attitude was similar to that of G, though less extreme. J and M, on the other hand, were over-anxious, afraid lest they might be mistaken, and therefore careful only to report what they could be certain of. This anxiety and uncertainty were also demonstrated in their absolute threshold curves, which were of the constantly fluctuating kind reproduced in Fig. 3. Q's deficiency was due partly to anxiety, but also to lack of training in this type of experiment.

Quite opposite were the attitudes of Subjects F, K, L and O. They were willing to 'take a chance on it' and make guesses in the hope that these were correct. In this L was conspicuously successful. He was unusually 'quick on the uptake' and adept at making the most of his rather poor visual equipment. But I and K were less successful. That is to say, their ability to perceive accurately was about what would be expected from their visual equipment; and their readiness to guess gave them only vague and not accurate ideas of what was presented.

With Subjects F and O this guessing was probably deleterious. F has already been referred to as the subject giving the fluctuating curve in Fig. 3, whose absolute threshold varied a good deal from day to day, becoming lower in the more interesting and higher in the more boring experiments. At the same time he exhibited a rather wild and reckless attitude to the silhouette perception, and was ready to advance guesses

at interpretation on quite inadequate grounds. Moreover these responses were over-determined by the content of the previous presentations, a characteristic also appearing in Subject O's responses, though less conspicuously. It is shown clearly in the tabulation of Subject F's responses in Table 5. He was a highly suggestible individual, and there is little doubt that he was temperamentally a poor observer in this type of experiment.

Table 5

Silhouette picture presented	First interpretation*
Man, horse and cart; horse has a flowing tail	North of Scotland
Ship at sea	A dog with a <i>long tail</i>
Two men and a dog	<i>Two sailing ships at sea</i>
Church with tower, and trees	Factory chimneys; or Stonehenge
Man, a sheep and a lamb	Animal, <i>wheeled thing</i> , man
Man and a fox	Man on <i>horseback</i> ; on a cliff by the <i>sea</i>
Church with spire, houses and a tree	Buildings
Yachts at sea	Islands with <i>trees</i>

* Interpretations derived from previous presentations are in italics.

It is also of some interest to study the relative perceptual ability of the subjects in cone vision, when they were able to see the details of the pictures with fair accuracy. A measure of the ability was given by averaging the intensities at which the subject set the illumination when he was required to increase it until he could see what the picture was (only those values have been averaged which were above the final cone threshold and which corresponded to an accurate perception of the picture). These figures are given in Table 4, and are plotted in Fig. 6 together with the figures for the final cone thresholds in this series. Two things are clear. There is a much closer correspondence between final cone threshold and perceptual ability in cone vision than there is between final rod threshold and perceptual ability in rod vision. There is a slighter correspondence between perceptual ability in cone and in rod vision; but this is greater than the correspondence between final rod threshold and perceptual ability in rod vision. In other words, there is a tendency for perceptual ability to remain relatively constant throughout the cone and rod periods of dark adaptation, and independent of the absolute threshold; but it is affected to a greater extent during cone than during rod vision by the absolute threshold. Now since perception during cone vision is in part dependent on perception of the details of the pictures, it requires the relatively high acuity of cone vision, and thus perceptual ability will be in part a function of the cone threshold. But certain subjects showed a considerable discrepancy between this ability and the final cone threshold—in particular Subjects B, D, H, and O were rela-

tively poor in perception, Subjects M and R relatively good. Now Subject B had a very unusually low cone threshold; but his perceptual ability has already been mentioned as rather inferior. But it seems that perceptual ability in cone vision was less dependent on intelligence than was perceptual ability in rod vision, since inference was much less in use. This is confirmed by Subject R's much better performance in cone vision. The fact that the average intensity for cone perception of this subject coincided with his absolute threshold was due to his tendency, already described, to set the absolute threshold too high. Subject Q's threshold readings were also too high, for the same reason.

The relatively poor perceptual ability of D, H, and O has already been commented on. It is interesting to note the improvement of Subject M. It appears that with the relatively well-defined sensory impressions of cone vision the anxiety caused by guessing was no longer operative; and a natural quickness in noticing and making use of detail in the pictures enabled him to perceive them strikingly well—better than any other subject except G.

It is clear then that the individual with a relatively low cone threshold will have a considerable advantage in perceiving any object sufficiently illuminated to exceed this threshold. On the other hand, the individual with the relatively low rod threshold will not have the same advantage in perceiving objects at lower intensities. But psychological abilities may qualify a low rod threshold and to some extent compensate for a high one. They will have less effect on this kind of cone vision.

(3) *Series IV*

In Series IV the perceptual task was again relatively simple, approaching that of Series II; but it was complicated by the accompanying motor task of tracing the maze pattern. It is true that this task involved very little manual dexterity, and in a good light the subjects could have performed it without making any errors. But the perceptual task was nevertheless made harder by the fact that it was to some extent doubled; that is to say, the subject had not only to observe the direction of the maze pattern (which changed frequently and was not uni-directional as was the dial hand); he also had to perceive, even if only vaguely, the position of the stylus, in order that the latter could be made to coincide with the former.¹

¹ Unfortunately, the ability to locate the position of the end of the stylus kinaesthetically from the position of the hand varied considerably in different subjects; thus some made much more use of kinaesthetic cues; others of purely visual cues. Obviously the former were at an advantage.

But in one respect this test gave a measure of perceptual ability which was very similar to that obtained in Series II—namely, the time until the subject could perceive the orientation of the white pointer which was set to point to the beginning of the first maze pattern. This time varied from $7\frac{1}{2}$ to 19 min. for the various subjects. Thus the relative ability of the subjects in this test might be expected to correspond to their relative ability in accuracy of perception of the dial hand at the periods either 10 or 20 min. after the beginning of dark adaptation. In Table 6 the three sets of figures are given; and they are plotted in Fig. 7 in ascending

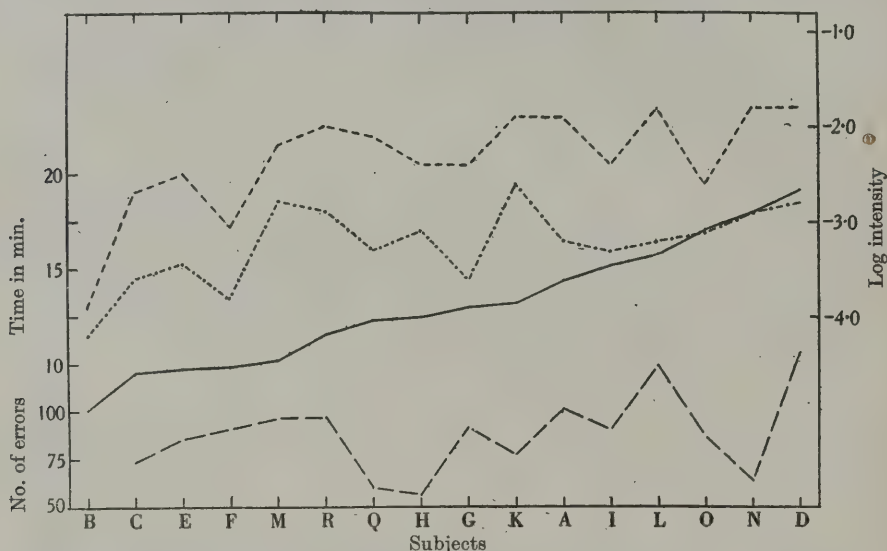


Fig. 7. Perception of pointer and number of errors in maze tracing. — Time until pointer was perceived in Series IV. — Number of errors in maze tracing in Series IV. - - - Average intensity for perception of dial hand after 10 min. in Series II. . . . Average intensity for perception of dial hand after 20 min. in Series II.

order of time interval for Series IV. We see that there is a correspondence between the sets of values, though it is not as close as that between the average intensity for the dial hand readings and the absolute thresholds in Series II. But an exact correspondence would not be expected, since Series II was performed with artificial pupils, Series IV with natural pupils. We cannot therefore draw any conclusions from the discrepancies between the two curves; but we are probably justified in assuming that the times taken to see the pointer in Series IV give an adequate measure of the same type of simple perceptual ability as was given by the average intensity for the dial hand readings in Series II.

Table 6

Subject	Series IV		Series II	
	Time till pointer was perceived	No. of errors	Av. intensity for perceiving dial hand	
			After 10 min.	After 20 min.
A	14.7	101	-1.9	-3.2
B	7.6	—	-3.9	-4.2
C	9.5	73	-2.7	-3.6
D	19.1	133	-1.8	-2.8
E	9.8	86	-2.5	-3.45
F	9.9	91	-3.05	-3.8
G	13.5	92	-2.4	-3.6
H	12.5	56	-2.4	-3.1
I	15.3	91	-2.4	-3.3
K	13.7	78	-1.9	-2.6
L	15.8	125	-1.8	-3.2
M	10.2	97	-2.2	-2.8
N	18.0	64	-1.8	-2.9
O	17.1	88	-2.6	-3.1
Q	12.3	60	-2.1	-3.3
R	11.6	98	-2.0	-2.9

The accuracy of the maze tracing in Series IV was measured by the number of errors—times that the pointer slipped off the maze on to the metal plate. These are given also in Table 6, and plotted in Fig. 7. Again there are discrepancies between the times until the pointer was perceived, and the number of errors in tracing. Subjects H, N, O and Q showed conspicuously few errors; Subjects L and D, possibly also M and R, an unduly large number. The subjects could of course regulate their own speed of tracing, but in no case shown here was frequency of errors due to high speed of tracing; those who traced slowly made more errors than those who traced more rapidly.¹ It seems that Subjects H and Q were as careful in their performance of this Series as they were in Series III; and Subjects N and O here showed a similar type of caution which did not appear in Series III. The frequency of errors shown by Subjects L and D was probably due to their poor visual acuity. Subject M's over-conscientiousness here had an effect opposite to that which occurred in Series III; he was so anxious not to be late in reporting the position of the pointer that he went to the other extreme and did so while it was still very faint and indefinite. Thus when he began to trace the first maze he could see it only very faintly, and was thus slow and inaccurate.

¹ Subjects J and P were possible exceptions to this generalization; they are not included here because they did not do Series II, which was carried out later than Series IV. Subject P's very large number of errors may have been partly, but not entirely, due to his fairly rapid speed; and Subject J was slow and accurate. But these two cases seemed exceptional.

On the whole the results of this series are rather disappointing, probably because of the impossibility of controlling the experimental conditions rigidly. There is some indication, however, that caution and anxiety, as well as the absolute visual threshold, may determine the accuracy of the performance. But they may affect it in a different manner from that in which they affected performance in Series III, which is explicable in view of the different psychological nature of the abilities involved.

IV. DISCUSSION

It is fairly clear, then, that the psychological basis of the perceptual performance in dim light, and hence the qualities required for it, may differ considerably in different perceptual tasks, and, indeed, may be almost specific to a particular task. There is no doubt, also, that familiarity with the situation and task is an important factor in assisting perception; and such familiarity again may be specific for the material, the situation and the particular observer. For instance, we have noted that the inexperience of Subjects Q and R affected their performance both in Series II and III. Again, in Series III, it was observed that pictures of men, objects which are familiar to most people in silhouette pictures, were always more readily perceived than the less familiar pictures of scenery. In particular, a picture of an Italian church, relatively strange to most observers, was generally found the hardest to perceive.

It follows, then, that it is exceedingly difficult to lay down any broad general conclusions as to the qualities and abilities which make for 'being able to see in the dark'. Of course it is undeniable that low absolute thresholds, both in cone and in rod vision, are of importance. Subject P, for instance, had a very high rod threshold. Unfortunately he was unable to carry out Series II and III, so that the effect of this on the perception of silhouettes could not be measured. But in Series IV his time to see the pointer, 18.2 min., was longer than anyone's except Subject D's, and his number of errors was the largest of all, 169. And there is little doubt that, however favourable his psychological qualities, he would have been greatly handicapped even in Series III. Other individuals, such as Subjects L and O, were relatively poor in seeing in moderately dim light, or just after coming out of a light room, because their cone vision thresholds were relatively high; but they were not so poor in seeing after a long period in the dark. Again, a high degree of refractive error may co-exist with a low absolute threshold, as in the case of Subject D, and may be highly deleterious to perception in the dark.

But on the whole the more complicated becomes the perceptual material and situation, and the vaguer the sensory data, the greater the extent to which perceptual ability is determined by psychological as well as by physiological factors. These psychological factors are both cognitive and affective, innate and acquired. The following are those discovered in the course of these experiments; but there may well be others which would appear in a more exhaustive enquiry with more subjects:

Cognitive factors. There is no doubt that *intelligence* plays an important part in helping the subject to 'guess at' the possible interpretations to be placed upon the incomplete sensory data, and to select those probable and relevant to his knowledge of the general situation. Subjects B and R showed quite clearly their inability to 'think of' possible meanings for the silhouettes. On the other hand in cone vision, where guessing played less part, intelligence was less important.

Education and general experience were of importance in directing the subject towards the best use of his natural abilities. They increased the ability to select the best interpretations. Examples of this type of selection were given on p. 219. But education and experience of a particular kind, namely the highly exact and scientific, seemed in tasks such as that of Series III to prevent the subject from exploring the full possibilities of the situation, because he could not obtain the accurate check on the sensory data on which he was accustomed to rely. This effect occurred also to some extent in cone vision, where it might be less expected. The responses of these individuals were either brief and business-like, omitting all but essentials; or gave rather long descriptions of the phenomenal appearance of the presentation, without much interpretation, thus: (First report): "Almost nothing except a few lumps in the middle; line dividing the picture above and below is slightly curved and rough." (Second report): "Completely different. One low rectangle at the left, then another, then a tall object. Something on the left. Can't identify them."

More specific experience and *familiarity* with the particular material and situation encountered were definitely helpful. Familiarity with material we have already discussed. For carrying out a task such as the continuous adjustment of a very dim light to threshold intensity, some experience in performing laboratory experiments was important. We formed the opinion that such experiments performed by untrained subjects might give quite misleading results. Either they would be variable in their readings, or they would consistently keep the intensity well above threshold so that the test patch was easily visible throughout. Such con-

ditions would not of course obtain in ordinary life. But it appears likely that the ability to perceive certain objects in very dim light might be considerably increased by training the observer in what to look for, and in giving him practice in picking it out, in specific situations such as he might have to encounter in ordinary life.

Affective factors. These were mainly innate, though there is no doubt that any acquired condition of emotional maladjustment might enhance the effect of some of them.

Considerable effects were produced by recklessness, caution, over-caution, anxiety and over-conscientiousness. The most favourable attitude was that produced by a moderate degree of *adventurousness*, a willingness to 'take a chance' that one's guesses might be correct. But a moderate degree of caution and self-criticism was also useful because it caused the subject to examine his guesses carefully before deciding on his interpretation. Too much *recklessness*, however, made him rush to conclusions and suggest something quite improbable, or give widely contradictory reports on succeeding exposures. Thus Subject F gave the following reports on a picture of a man, a woman and a dog walking uphill:

(First exposure): "Two sailing ships, yachts, and a fairly calm sea."

(Second exposure): "A bridge or something sticking out on the left."

(Third exposure): "A man walking with a wheelbarrow and a figure behind him."

(Fourth report): "Two hikers going uphill with a dog in front."

Closely allied to this was the tendency to *over-suggestibility*, shown in a readiness to produce interpretations based in whole or in part on the contents of previously presented material (see Table 5). It is probable that an individual with such a tendency would be very easily affected by any other factors in the situation which encouraged a particular type of response, i.e. 'suggested' what that response should be.

On the other hand, too much *caution* made the subject unwilling to guess at all, in case he gave himself away. This was particularly noticeable in the rather resistant type of individual who hates to be 'caught out', and who gave brief and banal responses. A rather similar effect appeared in the *anxious* and *over-conscientious* individual who was afraid to make mistakes and thus dared only to hazard an interpretation of which he was fairly certain, and gave responses such as: "A small figure, a tall figure, a small figure—might be anything." But it was interesting to note that the deleterious effect of this anxiety and hesitancy was much less in cone vision, presumably because the subject felt a greater certainty as to the detailed shape of the picture presented. However,

he showed its effect in his absolute threshold readings by the extreme fluctuation of the curve (see Fig. 3, Subject M).

Another characteristic which appeared less in the silhouette experiments with their variety and short exposures than in the longer and more monotonous experiments was liability to *boredom*. It was shown in the 'restless' type of fluctuation made by Subject F in Fig. 3, and by the increase of the absolute threshold in the duller experiments. This liability to boredom appeared in subjects both of the 'reckless' and of the 'over-cautious and resistant' type.

V. SUMMARY

Curves for the absolute threshold of vision of eighteen subjects were obtained continuously over a period of 55 min. dark adaptation, after previous complete light adaptation. Certain characteristic differences were found between the curves of the different subjects. Of these the most important were the relatively high threshold of certain individuals after cone adaptation together with a relatively low threshold after rod adaptation; while other individuals had a relatively low threshold after cone adaptation, and a relatively high one after rod adaptation. These characteristics were consistent for most subjects on repetition of the experiment. But a few subjects, particularly those liable to feel boredom, and those who had had little experience of experimental work, showed rather variable thresholds.

The ability of the above subjects to perform simple perceptual tasks during dark adaptation, such as reading the position of a dial hand, was very closely related to their absolute thresholds of vision. But the perception of more complicated material, such as silhouette pictures, was determined only partially by the absolute threshold in cone vision; and still less by the absolute threshold in rod vision. The ability of the subject to interpret the vague sensory data obtained in rod vision, and hence to make out the meaning of the picture, was affected by a variety of purely psychological qualities. Intelligence, education, and familiarity with and experience of the particular type of material and situation, were of great assistance. Affectively based attitudes were also important. Too much caution or timidity prevented the necessary amount of guessing at the meaning of the pictures; too much recklessness, and suggestibility to irrelevant influences, produced inaccurate guessing.

Attitudes of this kind also affected the performance during dark adaptation of a simple perceptual and motor task, the tracing out of a

dimly illuminated maze pattern; but the actual effects often differed from those occurring in the perception of silhouettes.

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THE DIFFERENTIAL THRESHOLD FOR THE SUBJECTIVE JUDGEMENT OF THE ELASTIC AND PLASTIC PROPERTIES OF SOFT BODIES

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I. INTRODUCTION

IN an earlier paper⁽¹⁾ experiments were described in which the thresholds for firmness were measured for two different types of soft body, namely a truly fluid bitumen and an almost truly elastic solid (rubber). In both these materials firmness depends upon single simple physical concepts, although these have different dimensions, namely those of viscosity in the one case and of elastic modulus in the other. Such materials are unfortunately rare. The kind of soft body generally met with in everyday life shows both plastic and elastic properties and it is difficult to say what firmness really means for these materials. It must depend upon some function of both plastic and elastic properties but the exact function is as yet unknown. Classical physics deals with this problem by treating the recoverable and non-recoverable deformations independently. From the psychological point of view this is clearly unsatisfactory, for some judgement for firmness can be and is made even before the pressure has been released, that is before it can possibly be known how much of the deformation is going to be recovered.

A treatment was suggested in the paper already quoted which would avoid this difficulty but which gives a 'firmness' having variable dimensions depending on other properties of the material. Experiments on the direct comparison of materials in which firmness has different dimensions (2) show, however, that this is far from being an insuperable difficulty for the average subject. A far wider experiment, in which subjects were asked to rank eight synthetic materials with mixed elastic and plastic properties, indicated that comparisons for firmness in such materials are made on the basis of total deformation, in that the rank order obtained from the pooled results corresponded more nearly with the order for total deformation after 2 sec. than with the order for any other physical measurement made. The relationship between these two interpretations of 'firmness' will be discussed later.

Unfortunately the total deformation will depend upon the pressure applied as well as upon the time of its application. Moreover, the relationship between deformation, pressure and time will not be simple as is the case with true fluids and true solids, since such complex materials almost invariably get progressively softer the harder they are pressed (structural viscosity) and progressively harder the further they are pressed (work hardening). Thus the actual sensory data received by any subject will depend upon the way in which he handles the materials, and the 'correct' order of firmness for any given set of samples will almost certainly vary for different individuals and even for the same individual at different times.

The difficulties opposing any sort of measurement of threshold under such conditions appear at first sight almost insuperable. There are, however, some four methods open for the investigation of the subjective judgement of such 'mixed' materials.

II. INVESTIGATION BY THE METHOD OF SELF-CONSISTENCY

By far the best method for comparing the efficiency of individuals seems to be to measure the self-consistency of their judgements by getting them to rank the same set of samples a number of times. Their ability to reproduce the same rank order will depend upon at least four factors: namely, (1) sensory acuity; (2) a stable mental criterion of firmness, to overcome the dimensional difficulties when the samples differ in 'spring'; (3) ability to select suitable test conditions or methods of handling, i.e. those giving maximum differences; and (4) ability to reproduce these test conditions.

This method was used by Scott Blair & Coppen(2) to compare the abilities of people having different types of training and was found quite satisfactory for this purpose, but it did not yield data directly relating subjective to objective differences nor any figures which could be compared with the threshold figures for other materials or other senses.

III. INVESTIGATION BY THE USE OF ARTIFICIAL MATERIALS

Perhaps the most obvious and ultimately the soundest solution of these difficulties is to use some kind of self-recording material which would record the pressures, deformations and times used on each sample by each subject, from which the actual properties of the material under these conditions could be calculated. One could, for example, have recording instruments embedded in the samples, but this would mean that the sample could not be homogeneous and it is not possible at present to say what effect this heterogeneity would have. The more obvious method of pressing the sample while it rests on a balance has the disadvantage that this is an unnatural method of handling for most subjects and also the movement due to the balance is added to the movement due to the change of height of the sample.

An alternative method would be to construct an artificial material. For example, small bulbs of some flexible but non-elastic material could be filled with mercury and connected to a manometer and to a capillary leak. The height of the column in the manometer would register the pressure and the additional volume of mercury would give a measure of the recoverable deformation, the volume expelled from the capillary leak giving a measure of the non-recoverable deformation. This method would eliminate the small differences in surface properties (e.g. stickiness) frequently found to accompany small differences in firmness, and might also affect some of the skin sensations in an artificial way, but these drawbacks are probably unimportant compared with the advantages. But the war obviates, for the present, the undertaking of such a task.

IV. INVESTIGATION BY THE USE OF KNOWN PRESSURES

A third method of attack would be to train subjects to use a known pressure, the time being either previously fixed or else measured during the test. The firmness could then be measured under the same conditions. Now the capacity to reproduce the test conditions is certainly a part of the ability to judge small differences in the firmness of those materials for which this property varies with the test conditions. The

capacity to reproduce a set of conditions arbitrarily fixed by the experimenter, however, is not a part of this ability. The following preliminary experiment was carried out in order to investigate whether subjects could be trained to use a known pressure, and if so, whether the fact that the choice of pressure was arbitrary would affect reproducibility.

The subject was given 2 min. in which to practise reproducing a pressure of 10 lb. by pressing with the thumb on a cork of diameter 2 cm. placed on a Post Office parcels balance. The subject was then asked to reproduce this pressure twenty times at intervals of 20 sec. without seeing the dial. The experimenter gave the signal 3 sec. before the subject began and took the reading on the dial of the balance at a signal given by the subject.

The subjects did the test three times each, then repeated the test 20 hr. later, omitting the practice period. They were shown their results and immediately did another repeat, again without further practice. A third subject was first asked to reproduce any pressure she liked ten times without looking at the dial. This she repeated until she had done six such tests, she was then given the other test to do. The results of all the tests are given in Table 1.

Table 1

		Reproduced pressure in lb. in test number					
Subject		1	2	3	4	5	6
		(a) No standard pressure					
3	Mean	9.1	8.5	8.9	8.8	5.9	5.8
	Mean deviation	0.4	0.5	0.7	0.4	0.6	0.3
		(b) Standard pressure 10 lb.					
3	Mean	10.3	10.6	—	—	—	—
	Mean deviation	0.7	0.3	—	—	—	—
1	Mean	13.3	10.2	9.8	7.5*	8.1*	—
	Mean deviation	0.8	1.2	0.8	0.7	0.8	—
2	Mean	13.1	12.3	10.4	11.9*	9.4*	—
	Mean deviation	1.1	0.7	0.7	0.8	0.4	—

* No practice period.

These results indicate that subjects can be trained to reproduce a given pressure with sufficient accuracy to justify us in making our objective measurements at this pressure. Moreover, the one subject who also carried out the test using her own standard pressure showed no appreciable difference in accuracy of reproduction when asked to do the test with a standard pressure arbitrarily fixed at 10 lb. These tests would, however, have to be carried out by every subject who was asked to make any judgements using an arbitrarily chosen pressure, to make sure that

the results hold for everyone. This in itself would be a somewhat lengthy procedure and it would not even then be known whether this ability acquired with a Post Office balance and a cork could be transferred to the test situation. The subjects may, for instance, have judged by the extent of the movement required rather than by sensations of tension and pressure. The effect of this additional task on the subjects' accuracy of judgement, mental attitude, etc., as distinct from their ability to manipulate the materials successfully, would also have to be investigated. In fact, although the evidence is sufficient to indicate that this is a method which might profitably be pursued further, a whole programme of research would have to be carried out on subsidiary investigations before any confidence could be placed in results obtained by the use of such a method. Moreover, it would still involve measuring abilities other than those necessitated in making judgements of the required character.

V. A METHOD OF CALCULATION FROM SELF-CONSISTENCY DATA

In view of all the difficulties attending the methods described above, it seemed worth while, especially since work on the problems of subjective judgement of firmness is still at such an early stage, to attempt to calculate the threshold from the data already obtained in the earlier experiment on self-consistency (2), even though, admittedly, this would give us information only as to the order of magnitude of the threshold, one of the above more cumbersome methods being necessary for more accurate information.

The data available were the rank orders assigned by nineteen subjects on twenty-five different occasions to eight samples of a specially prepared synthetic material which varied in both spring and firmness. When the experiment was completed, the samples were cut up and objective measurements made under conditions which were as near as possible similar to those used by an average subject. Some of the samples appeared to change slightly during the course of the experiment and, when due allowance was made for this, it appeared that the rank order derived from the means of all the subjective judgements agreed very well with the order of total deformation obtained in the objective tests.

Since the samples changed slightly during the experiment and since also the rank order even for total deformation would depend upon the conditions of testing or handling, the 'objective' differences upon which a subject based any individual ranking would depend upon the time at which the test was done and upon the subject who did it; so that in order to work out a threshold, some way must be found of calculating the

objective differences for each person for each half of the experiment taken separately. As a tentative way of doing this, it was assumed that the differences between the mean subjective ranks for each subject for each half of the test were proportional to the differences between the mean total deformations produced by that subject for that half of the test; that is, that in general the subjects' judgements were correct. It might equally have been assumed, remembering Fechner's work, that the subjective differences would correspond with the differences between the logarithms of the total deformation, but for the sake of simplicity the first assumption was made. It was also assumed that the hardest and the softest samples did not change appreciably either with time or with method of handling. Since all subjects agreed as to which were the hardest and the softest and since the mean ranks for these two samples did not change perceptibly during the test, this seems a not altogether unfair assumption to make. Having thus fixed the maximum objective difference, the 'objective' difference for any given pair for any given subject for half the test was taken as a proportion of this, the proportion being determined by the ratio of the difference in the mean subjective ranks of the two samples to the difference between the mean subjective ranks of the hardest and the softest samples for that subject for that half of the test. For example, if eight samples have mean subjective ranks, a, b, c, d, e, f, g, h , and if the hardest (a) and the softest (h) give total deformations A and H respectively, then the objective difference $D-E$ may be calculated as follows:

$$\frac{D-E}{d-e} = \frac{A-H}{a-h} \quad \text{or} \quad D-E = \frac{(A-H)(d-e)}{a-h}.$$

This was then taken as a percentage of the deformation for the hardest sample. Now clearly, for those samples which were confused with only one other, the difference in mean rank would be determined solely by the number of times that one was judged greater than the other and not by the *extent* to which it was judged greater, so that with this method of calculating, the 'objective difference' and the percentage correct answers would be different expressions of the same data. For this reason the only pairs selected for analysis were those in which at least one of the pair had been confused with a third sample so that the two mean ranks depended not only upon the number of times one was judged greater than the other, but also upon the extent to which one was judged greater or less than the other. Any sample which was not confused with any others was omitted from the analysis since there was then

no measure of the size of the interval between it and adjacent samples. Similarly, if the data tended to fall into two or more groups which were not confused with each other, pairs made up of samples from different groups were not used. Samples which showed a definite drift from one position to another were also omitted.

VI. COMPARISON OF 'MIXED' AND 'SIMPLE' THRESHOLDS

As many pairs of samples as possible were selected in this way from the records of all the subjects. The data were then grouped conveniently and means were calculated. The results are plotted in Fig. 1*a*. Data obtained from pairs that were confused only with each other are also given and it will be seen that the points fall on a straight line. The results obtained from the other pairs form a smooth curve differing markedly from this line, showing that some quite different function is being measured. Moreover, this curve is similar in shape to the curves obtained for the viscosity and modulus thresholds, except that there is a marked tendency to flatten out near the 50 % correct level. This is probably due to the fact that the smaller the differences, the more the relative mean positions of the two samples will tend to be influenced by the number of times one is judged greater than the other and hence the nearer the curve will approach to the straight line obtained for pairs confused only with each other, which cuts the zero difference line at 50 % correct. For this reason data on small differences are considered definitely unreliable and differences below 10 % have been excluded from the calculations.

If, neglecting these points, we plot the logarithm of the percentage difference ($\log \Delta$) against percentage correct answers, as was done for the viscosity and elastic modulus thresholds, we get a fairly good straight line (Fig. 1*b*), having a slope significantly lower than that for rubber ($P \leq 0.01$)¹ and only slightly lower than that for bitumen ($P > 0.05$) which it crosses at the 40 % level. This means that the threshold for such a mixed system is barely distinguishable from that for a true fluid. In view of the difficulties of handling the materials and maintaining a stable criterion of firmness in the face of its varying dimensions this threshold is surprisingly low, though it must be remembered that having assumed in the first place that the subjects are in general correct, this method of calculation would tend, if anything, to give an artificially low threshold.

¹ Lines were fitted by the Method of Least Squares and the sampling errors of the ordinate of the centroid and of the slope were estimated on the assumption that the experimental errors of single points were predominantly in the ordinates: this assumption is probably not entirely justified, but it was considered that the data were hardly sufficient to warrant a more detailed apportionment of the errors between ordinate and abscissa.

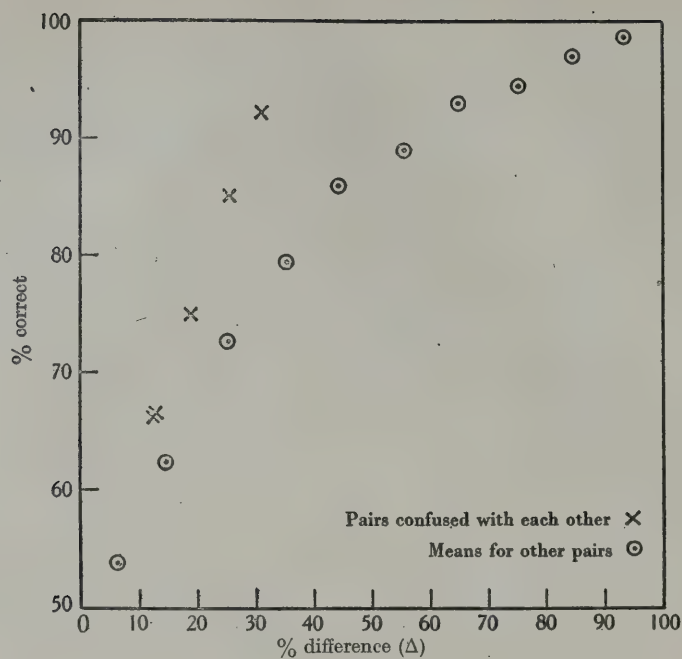


Fig. 1 a.

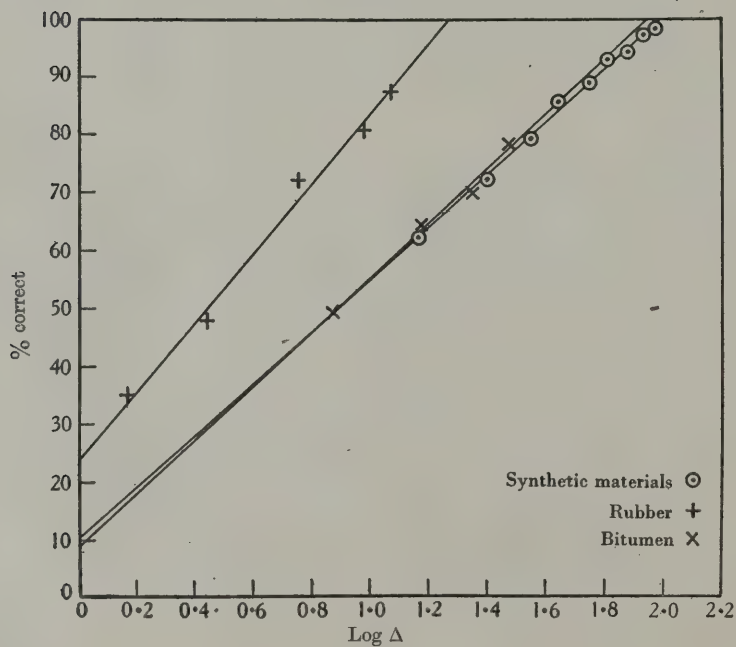


Fig. 1 b.

VII. COMPARISON OF THRESHOLD CURVES FOR ONE CHEESE-MAKER FOR CHEESE AND FOR OTHER MATERIALS

One of the technologist subjects who did the tests with the bitumens, rubbers and synthetic materials, also gave judgements over many months on cheese curd at a certain stage (the pitching stage) in the manufacture of Cheddar and Cheshire cheese. Several cheeses are made each day under the supervision of this expert, who felt each curd just before it was 'pitched' and gave an opinion as to whether it was normal, slightly soft, very soft, slightly firm, very firm, etc., for this stage of manufacture. Altogether she used about eleven such categories of judgement. In this way a rank order could be obtained for the cheese made on any one day. The percentage difference in firmness between each curd and every other curd made that day was calculated from data obtained from an objective test described by Scott Blair & Coppen⁽³⁾ and the differential threshold curve was plotted.

Cheese curd at the pitching stage is a somewhat unusual material in that it consists of tiny particles from about 25 to 500 μ m.³ in volume, suspended in whey. When judging for firmness the experts both feel the impact of the particles while stirring in the whey and also squeeze a handful which has been removed from the whey. This particular expert apparently used mainly the latter method. In spite of this difference from the other materials it is of interest to compare this threshold curve with the other curves for the same subject, since she might be expected to give a better performance in the field in which she was especially trained. The results are given in Fig. 2.

Unfortunately this subject's curve for the bitumen experiment is too irregular to be included. The general curves for all subjects are included for comparison.

It will be seen from Fig. 2 that the curve for cheese curd shows a marked curvature, but that nevertheless this subject's performance when dealing with her own material was throughout superior to her performance when dealing with the synthetic cheese-like materials and superior to the average performance for both the true fluids and the synthetic materials. Moreover, for differences above 10 % her performance is actually superior to her own performance on the elastic solids, though still inferior to the average for these materials.

In view of the fact that cheese curd shows properties very similar to those of the synthetic materials, the relative position of the two curves is very striking and seems to afford definite evidence of a superior ability

resulting from training. It must, however, be remembered that 'springiness' and firmness are definitely correlated in cheese curd but not in the synthetic materials. This would tend to make judgement relatively easier when dealing with the former material, since for the small differences there would be little difference in 'spring', thus avoiding the dimensional difficulty; and for the larger differences there might be a sufficiently big difference in 'spring' for the subject actually to judge by this difference in quality as well as, or instead of, the difference in

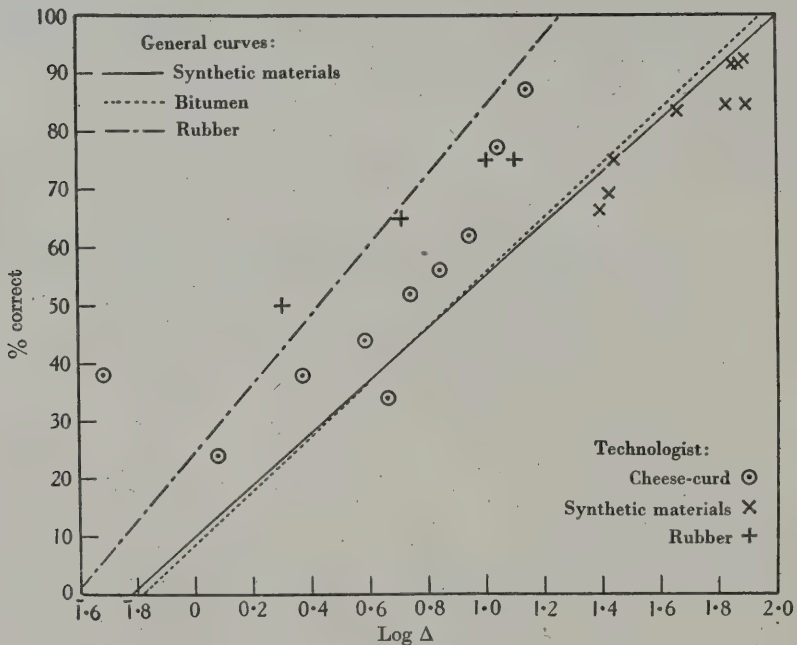


Fig. 2.

firmness. These considerations would account not only for the relative positions of the curves for the synthetic materials and for cheese curd but also for the marked curvature of the latter curve. Added to this, there is probably some correlation between the size of particle and firmness, especially at the extremes, the fine cut curds usually being somewhat firmer objectively and feeling still firmer than the objective test would suggest, thus again exaggerating the great differences.

It appears that in general the slopes of the threshold curves for this subject are considerably lower than the slopes of the general curves. This

suggested that the slope might be characteristic of the subject or of the group for all materials and further plottings for other subjects were done in order to investigate this possibility.

VIII. COMPARISON OF DIFFERENT GROUPS OF SUBJECTS

The data from individual subjects were unfortunately very irregular but where comparison was possible there seemed to be no consistency of slope. The data for groups of subjects having similar training are, however, quite interesting.

In the previous experiments the two most interesting groups were the expert cheese-makers (τ -group) who are trained in judging for firmness and the routine analysts (ρ -group) who although untrained were almost invariably superior.

The data for these two groups and for the remainder of the subjects were plotted separately for each of the three materials used and the best straight lines were fitted. The results are given in Fig. 3.

The superiority of the ρ -group is again demonstrated in these figures. In every case where there is a significant difference in level between two lines, the ρ -group is involved and is invariably superior. Thus with the rubber cylinders the ρ -group was superior to the rest ($P < 0.01$); with the bitumens ρ was superior to τ ($P < 0.05$) and probably superior to the rest (P just > 0.05); for the synthetic materials ρ was superior to the rest ($P < 0.05$).

As regards differences in slope, these were disappointing, no significant differences being found either for the bitumens or for the synthetic materials. For the rubber, however, the τ curve was lower in slope than either the ρ curve ($P < 0.05$) or the rest (P just > 0.05). The reasons for a difference in slope are hard to determine but it seems likely that they could be caused by differences in the influence of chance factors on the subjects, though if this is the case it seems surprising that chance factors should apparently have played a more important part in the task which is, of the three, the simplest from the point of view of physical theory and is also reported to be the easiest to perform. It may be, of course, that this very simplicity gives rise to boredom and it has already been suggested^(1,2) that the expert technologist cheese-makers are more susceptible to boredom than are other categories.

It appears then that, as in previous experiments and also in the previous analysis of these data, the technologists are in no way superior to the average in judging the firmness of the materials used. It still remains possible, however, that this is merely due to failure to transfer

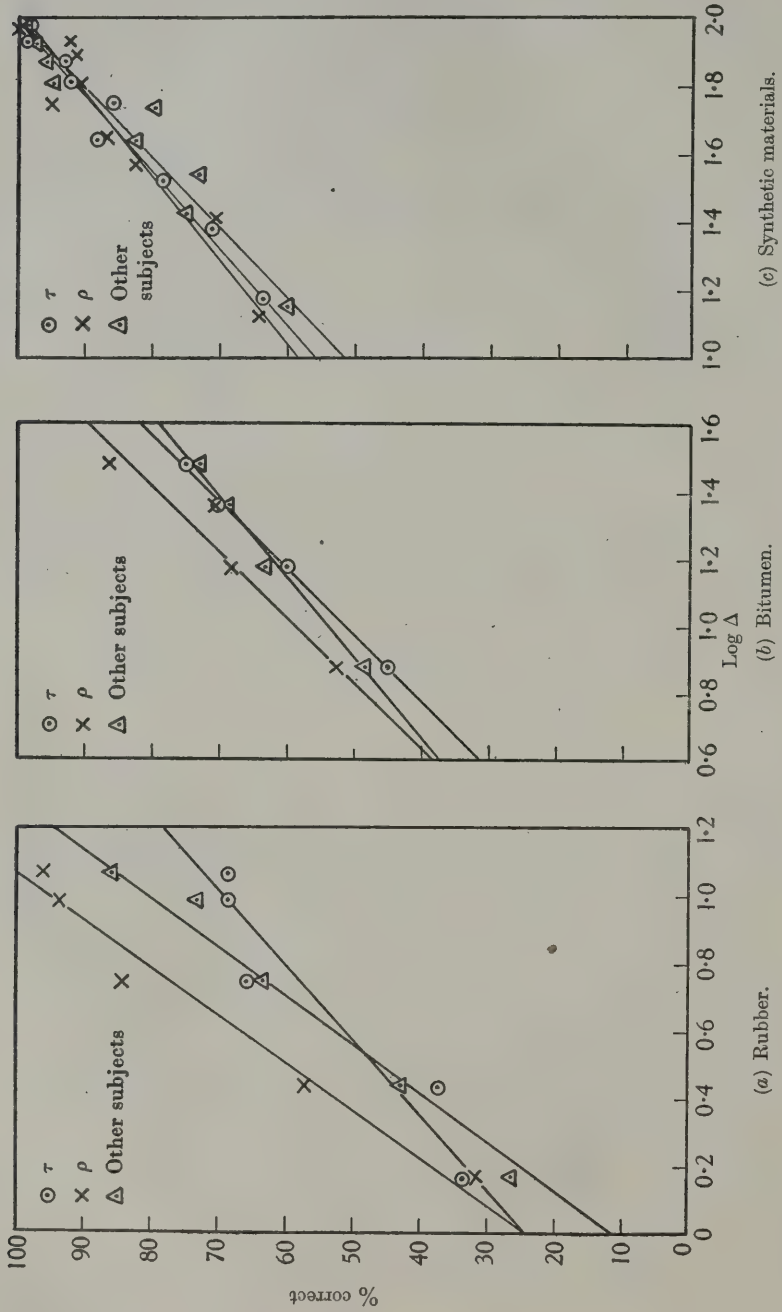


Fig. 3.

ability and that they may show superiority when dealing with their own materials. This seems especially likely considering the results of the one expert cheese-maker whose threshold for cheese curd was measured. One might have expected, though, that the ability to reproduce test conditions and to maintain a stable mental criterion of firmness would be transferable, whereas no such transference is shown in this experiment. On the other hand, ability to select *suitable* test conditions acquired when dealing with cheese-curd might very well not be transferable to a new material and it is possible that this factor plays its part in the superiority shown by the single cheese-maker tested on her own materials, though the alternative explanations seem more likely.

IX. GENERAL DISCUSSION

The results obtained by this method of calculation serve to indicate the importance of the ranking method as a way of measuring a differential threshold where judgement is slow. It has the great advantage for this type of work that it is far quicker than any other method. By one ranking of eight samples, a subject has in effect given judgements on twenty-eight pairs, and the average time taken to do this for the samples used in this experiment was less than 5 min., whereas most subjects took about 20 min. in the modulus experiment and about 40 min. in the viscosity experiment, to give the same number of judgements by a modification of the method of paired comparisons.

A more important question which arises when considering the whole of this and similar work (cf. Katz⁽⁴⁾ on flour-doughs and Binns⁽⁵⁾ on softness of wool-tops) is the question of the true nature of the subjective concept 'firmness'.

Sullivan⁽⁶⁾ has approached this question by attempting first to analyse by means of introspections, then to synthesize the cutaneous perception of 'softness' and 'hardness'. Wooden and metal cylinders, wads of cotton, etc. were pressed on the subjects' hands and it was found that hardness and softness depend on:

- (1) The pattern of pressures in the area stimulated;
- (2) The sharpness of the boundary line;
- (3) Temperature.

Neither intensity of pressure nor lateral movement seemed to play any appreciable part. She came to a somewhat similar conclusion in her experiments on the cutaneous perception of 'liquidity', 'semi-liquidity' and 'solidity'⁽⁷⁾, in that pressure and temperature were found to be the

dominant factors, time effects playing a negligible part. This is very surprising, for the physicist and probably most laymen would define 'firmness' as some function of the relationship between the pressure applied and the amount or the rate of the deformation or flow produced; which leads to the conclusion that the cutaneous senses can play little or no part in the judgement of 'firmness' in this sense and in fact may well provide a serious source of error. This, indeed, was shown by Sullivan herself for, in comparing wooden cylinders, she got marked reversals of judgement with differences in the roughness of the surfaces or with temperature differences. Unfortunately the whole of this work was somewhat marred by the, at that time, almost inevitable lack of rheological knowledge, with consequent confusion and ambiguity of terminology. Nevertheless, these factors emphasized by Sullivan may have to be taken into account in a full study of the subjective concept of 'firmness', though it must be remembered that they are not part of what a subject consciously means or understands by the word 'firmness'; rather they are properties which under suitable conditions may arouse an illusory perception of 'firmness' or 'softness'.

The appropriate stimuli for a perception of what is consciously meant by 'firmness' are of necessity many and varied and include lateral movement over the skin, pressure on the skin and underlying tissues and tension and movement in muscles and joints. Considering the problem from the purely psychological point of view, it is most probable that 'firmness' is an 'emergent character' resulting from such simple sensory data in a manner such as is described in Watt's *The Sensory Basis of Knowledge* (8). For example, he says, "When two pressure contacts are set some distance apart on the skin...we notice the presence not only of the two spots of sensation, but of another sensory datum, namely, the *distance* between them". This distance is not a property inherent in the spots although it is inevitably bound to them, it seems, in other words, that it is part of the Gestalt but not part of the stimuli which form the basis of the Gestalt. Similarly, it may be that 'firmness' is an 'emergent character' resulting from certain sensations of pressure and movement. Certainly something of the sort must be true, though how far one would be justified in regarding 'firmness' solely as the 'emergent character', that is, as that which is a property of the Gestalt but not of the parts or how far one should regard it as the *whole* Gestalt, it is impossible at this stage to say.

In either case one would have to assume that the basis of the Gestalt, or the conditions for the emergence of the new character, are not always

the same, that is, that the presence or absence of another factor, time, does not affect it. For, as has been previously shown, the term 'firmness' is applied with equal ease to true fluids where it can only be an expression of the proportionality between stress and *rate* of strain and to true solids where it can only express the proportionality between stress and *amount* of strain independent of time. Moreover, the data from the cutaneous senses alone can give rise to an experience of 'firmness' or 'softness', or they can be eliminated for comparative purposes without preventing comparisons for firmness.

From the purely physical point of view the problem is still more complex. For the simple systems, true fluids and true solids, the position is clear enough. Firmness can refer only to the compression modulus in the latter case, and to viscosity in the former, but for intermediate materials there is an almost infinite series of viscosities for different stresses, another series for different strains and in all probability there are many different compression moduli also. In view of these difficulties, in the present experiments, measurements of deformation and of recovery were made under conditions of stress and strain as near the estimated average used by our subjects as could conveniently be done. It was unfortunately impossible to use as short a time as used by the subjects, and 2 sec. was used which is at least twice the average subjective time. The various measurements were then compared with the mean subjective ranks for all subjects in order to see which measurement correlated most nearly with 'firmness' as understood by these subjects. The best agreement was found for the inverse of the total deformation under a standard stress acting for the given time (2 sec.).

This is interesting in view of the equation proposed by Nutting⁽⁹⁾ and later independently by Scott Blair & Coppen⁽¹⁾ giving the following expression for firmness (ψ)¹:

$$\psi = S\sigma^{-1}t^k,$$

where S = shearing stress, σ = total strain, t = time, k is a parameter between 0 and 1.

For unit time (1 sec. on this occasion) $\psi = S\sigma^{-1}$, or for a given stress firmness is inversely proportional to total deformation. Now in this case t was 2 sec. and yet subjective firmness was apparently proportional to total deformation which suggests that unit time for these subjects was of the order of 2 sec. even though the actual time of compression was less than

¹ There is something to be said for defining the physical concept 'firmness' as $\log_{10} \psi$, but the matter is not yet fully settled.

this for most subjects. This corroborates the findings of another experiment⁽¹⁰⁾ in which the materials judged were a true fluid and a true solid, i.e. where the difference in k was maximal. In this experiment it was found that for a compression time of 1 sec. a true solid would be judged of the same firmness as a true fluid of viscosity numerically three times the modulus of the solid, in other words the ratio of subjective to objective time unit appeared to be of the order of 3, or, taking the usual physical unit of 1 sec., the subjective unit was found to be 3 sec. It appears then that in judging firmness the subjective unit of time is not the same as the physical and is not even a constant but depends upon the difference in k for the two samples, decreasing as this difference decreases. This matter is being further investigated.

X. SUMMARY

1. The difficulties from both the physical and psychological points of view of comparing for firmness materials which vary also in 'spring' are discussed, and methods of overcoming these difficulties suggested and criticized.

2. Investigation by measuring self-consistency of judgement is useful for comparing individuals but gives no direct data concerning objective differences from which a threshold may be calculated.

3. The use of artificial self-recording materials is recommended but the effects of necessary differences from normal materials would have to be investigated.

4. The use of a known pressure is suggested and a preliminary experiment described in which ability to reproduce a pressure chosen by the experimenter was measured and this ability compared with reproducibility when the pressure was chosen by the subject. Results indicated that this is a promising line of approach but further investigations are necessary before it can be used.

5. A method is described by which, if certain reasonable assumptions are made, the necessary data for a threshold curve can be estimated from self-consistency data already obtained.

6. The threshold curve so derived was found to be almost indistinguishable from that for the firmness or viscosity of true fluids.

7. The threshold curve for cheese curd for a skilled cheese-maker is compared with other threshold curves and found to be lower than those for true fluids and for synthetic cheese-like materials. Possible reasons for this are discussed.

8. A logarithmic plotting of the curves for different groups of subjects confirmed the superiority, shown as threshold level, of the routine-analysts. Differences in slope were insignificant, except in one case where the technologist group showed a lower slope, lending added weight to previous suggestions concerning the mental attitude of this group.

9. The meaning and nature of the subjective concept 'firmness' are discussed.

The author wishes to thank Dr P. White for his help with the statistical treatment of the data, the late Mr F. Johnson Dix for his encouragement and many valuable ideas including specifically those regarding the design of artificial materials, and Dr Scott Blair for his co-operation on the experimental side and continued help and advice.

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THE USE OF INTERACTIONS IN ANALYSING PSYCHOLOGICAL DATA

By WILLIAM STEPHENS TAYLOR

- I. *Introduction to the use of interactions* (pp. 248-249).
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 - VI. *Conclusion* (p. 258).
- References* (p. 258).

I. INTRODUCTION TO THE USE OF INTERACTIONS

The purpose of this paper is to urge the importance of calculating interactions for all quantitative psychological data ordinarily analysed by correlational methods. The statistic for interactions is that obtained in the calculation of the Analysis of Variance^(1,2).

The value of this statistic for the analysis of psychological data appears in two main ways:

(a) It supplements the calculation of correlations by giving additional information about the interrelations of series of observations, and suggests that the correlation coefficient, by itself, provides an inadequate basis for a psychological analysis which is supposed to be in any sense exhaustive.

(b) More particularly it gives specific information about the way in which two or more abilities, as measured, for instance, by particular tests, co-operate to produce the standard of achievement with which the individual is credited. In this way it gives an important type of information about the interrelationships of abilities which cannot be obtained adequately from the correlation coefficient.

The use of this statistic as a supplement to correlations requires little extra labour, as the sums of squares of deviations about the mean are already given in the calculation for correlations. When used independently the calculation of interactions requires less labour than the calculations of correlations, as it does not involve the use of sums of products.

The meaning to be drawn from the statistic for interactions may be illustrated by the following example (1), Chap. VII, Table 46):

	Basal dressing	Sulphate
Kerr's Pink	8.88	10.43
Nithsdale	8.38	8.36

The statistic for interactions would disappear if the entries were strictly in proportion, that is, if 8.88 was to 8.38 as 10.43 was to 8.36. The statistic for interactions measures the extent to which the entries deviate from this strictly proportional form. The meaning of the disproportion is derived from the nature of the particular experiment. In this instance it would indicate that the addition of a sulphate dressing was effective in increasing production only in the presence of a certain species of potato plant. The sulphate dressing was not operative in virtue of its own characteristics alone, but in virtue of a conjunction between its own characteristics and another specified factor. The co-operative action of sulphate dressing and certain plant characteristics produced an effect which could not be explained as a merely additive effect of the contributions each makes independently.

In the calculation of disproportionate entries by interactions, a reliable statistical measure of significance is obtained.

II. THE METHOD OF CALCULATING INTERACTIONS

The following hypothetical example will indicate the nature of the calculation involved in estimating the statistic for interactions.

The principle of the analysis is given in Fisher's equation

$$S(x - \bar{x})^2 = S\{n_p(\bar{x}_p - \bar{x})^2\} + SS(x - \bar{x}_p)^2.$$

When the mean values of the different groups into which the scores can be divided do not differ significantly among themselves, the sum of squares of deviations about the grand mean does not differ significantly from the sum of squares of the deviations of the scores about their group means, i.e. the second term of the equation virtually drops out. Where the group values do differ among themselves, however, this is not true. In this case the analysis of variance divides up the total sum of squares of the deviations of all scores about the grand mean into the portion attributable to the differences between the mean values of specific groups, the portion attributable to the disproportionate relations between the mean values of the groups (i.e. interactions) irrespective of absolute differences, and the portion attributable to deviations of the scores within each group about its group mean. In normal procedure the difference

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between the means of any two groups is tested for significance against the deviations of the observations within the groups from their own group means. The same procedure is followed here. The sum of squares attributable to deviations of the observations within groups from their group means provides the value against which the other estimates are

	Test I			Test II			College A totals:	
College A	21			24				
	19			15				
	25			13				
	24	<i>Sx</i>	230	24	<i>Sx</i>	210	<i>Sx</i>	440
	20	Mean	23	30	Mean	21	Mean	22
	25	$(Sx)^2$	52900	18	$(Sx)^2$	44100	$(Sx)^2$	193600
	30	$S(x^2)$	5476	25	$S(x^2)$	4676	$S(x^2)$	10152
	30			16				
	18			25				
	18			20				
College B	22			24			College B totals:	
	24			32				
	26			18				
	23	<i>Sx</i>	300	12	<i>Sx</i>	200	<i>Sx</i>	500
	37	Mean	30	20	Mean	20	Mean	25
	32	$(Sx)^2$	90000	15	$(Sx)^2$	40000	$(Sx)^2$	250000
	40	$S(x^2)$	9344	30	$S(x^2)$	4428	$S(x^2)$	13772
	35			21				
	30			15				
	31			13				
Total Test I			Total Test II			Grand total		
<i>Sx</i> 530			<i>Sx</i> 410			<i>Sx</i> 940		
Mean 26.5			Mean 20.5			Mean 23.5		
$(Sx)^2$ 280900			$(Sx)^2$ 168100			$(Sx)^2$ 883600		
$S(x^2)$ 14820			$S(x^2)$ 9104			$S(x^2)$ 23924		

Total s.s. of deviations from the grand mean

$$= S(x - \bar{x})^2 = S(x^2) - \frac{(Sx)^2}{N} = 23924 - \frac{883600}{40} = 1834.$$

Total s.s. of deviations for group differences and interactions

$$= \frac{(Sx)^2 + (Sx)^2 + (Sx)^2 + (Sx)^2}{\text{No. in each group}} - \text{c.f.*}$$

$$= \frac{52900 + 90000 + 44100 + 40000}{10} - \text{c.f.} = 610$$

$$\text{s.s. for college differences} = \frac{(Sx)^2 + (Sx)^2}{\text{No. in group}} - \text{c.f.}$$

$$= \frac{193600 + 250000}{20} - \text{c.f.} = 90$$

$$\text{s.s. for test differences} = \frac{(Sx)^2 + (Sx)^2}{\text{No. in group}} - \text{c.f.}$$

$$= \frac{280900 + 168100}{20} - \text{c.f.} = 360$$

$$\text{s.s. for interactions (obtained by subtracting the specific group differences from the total attributable to group differences and interactions)} = 160$$

$$\text{s.s. of deviations within groups} = 1834 - 610 = 1224$$

* c.f. (correction factor) for sums of squares is always $\frac{(Sx)^2}{N}$ as in first line of calculation

tested for significance. When estimating the sums of squares of deviations attributable to group differences, any groups or combinations of groups may be used, with the single proviso that in making any comparisons, all the observations belonging to those groups must be used in the calculation. As the example on p. 250 shows, the various groups are treated separately in estimating the total sum of squares attributable to group differences and interactions, and are then taken in various combinations to isolate particular group differences. The various sums of squares are reduced to a statistic ' z ' in order to test them for significance. This is done by calculating $\frac{1}{2} \log_e$ of the mean square of the various sums of squares obtained, and subtracting the log of the 'within groups' value from the logs of other values.

	s.s.	Degree of mean		$\frac{1}{2} \log_e$	' z '	P 0.05*	P 0.01*
		Freedom	Square				
Between college groups	90	1	90	2.2499	0.4867	0.7141	1.0116
Between test groups	360	1	360	2.9431	1.1799	0.7141	1.0116
Interactions	160	1	160	2.5376	0.7744	0.7141	1.0116
Within groups	1224	36	34	1.7632	—	—	—

* These values are given in Fisher's tables (1).

III. THE USE OF INTERACTIONS WITH PSYCHOLOGICAL DATA

The statistic for interactions may be used with psychological data, independently of the calculation of correlations, to give the type of information described above. The following is an example:

	Test of eductive ability	Logical memory test
Test taken in native language	21.6	19.4
Test taken in acquired language	20.2	13.8

The values entered are mean scores for groups of forty-one and forty-five students respectively. It is obvious that the language in which the test is taken has a much more significant influence in conjunction with the ability required by the logical memory test than in conjunction with the ability required by the test of eductive ability. The influence of the language difference becomes operative only in conjunction with another specified factor.

In a situation such as this the number of tests used may be increased indefinitely, and those test abilities isolated in conjunction with which the difference of language becomes significantly effective. Similarly, any differences or groups of differences which the experimental procedure requires may be used in place of the language difference of this example.

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There are many of these which are of particular interest for social and educational psychology, such differences as those of sex, age, educational achievement, race, nationality, religion, economic status, family type. The calculation of interactions is of particular value in isolating the characteristics in conjunction with which the occurrence of such differences becomes socially and psychologically important.

By a slight modification in experimental design, the calculation of interactions can be used to give information about the interrelations of mental abilities which is of importance to theoretic psychology. It can indicate, (1) those abilities which tend normally, with given types of problems, to be used in conjunction, and (2) those abilities which, when occurring in conjunction, produce an increase of effectiveness which cannot be explained either by the intrinsic features of either or both of them taken in isolation or by merely additive effects of their contributions; thus such abilities are distinguished from others whose occurrence in conjunction has a neutral, or merely additive effect. One need only substitute for language differences, in the above example, differences in the degree to which two or more groups possess an ability as measured by a particular test, and calculate the interactions with abilities as measured by other tests.

In the following example two groups are used, of which one had a relatively high degree of eductive ability as measured by the Analogies test, and the other a relatively low degree of eductive ability as measured by the same test. The high eductive group is composed of students having the upper third of scores on the Analogies test, and the low eductive group of students having the lower third of scores. The figures are taken from the scores of students in India on a battery of tests. It will be noticed that the standard of achievement, as indicated by the mean values, varies considerably from test to test. In the calculation of interactions the sums of squares of deviations from the mean attribute to such differences in standard of achievement are partialled out before the value for interactions is calculated, so that the latter remains a statistic based only on the proportional relations of the values, however these may differ in absolute value from test to test. Table 1 gives the mean scores for the two groups on eight tests, and Table 2 gives the calculated values of the interactions when the tests are taken by pairs in all possible combinations (p. 254). The entry in any row and column indicates the value of the interaction between the eductive groups and the tests indicated by that row and column. For example, the value given in row 3 column 5, which we may for convenience designate as I_{35} , is the value of the interaction

between the eductive groups on the one hand, and the abilities required by the tests of Absurdities and Cancellation A on the other. By reference to Table 1 we see that the values from which this interaction is derived may be presented, as in previous illustrations, in the following form:

	Absurdities	Cancellation A
High eductive ability	63.1	39.5
Low eductive ability	46.0	42.0

One may interpret the interaction as indicating that the possession of high eductive ability is a positive help in the response to the Absurdities test to a much greater extent than in the response to the Cancellation A test. In terms previously used, the conjunction of high eductive ability with the other abilities required in the solution of the Absurdities test produces a much greater measure of achievement than does the conjunction of high eductive ability with the other abilities required in the Cancellation A test. The differences in achievement cannot be explained by differences between the two levels of eductive ability alone, nor by differences between the test problems alone, nor by the merely additive effects of the two, but must be explained as an enhanced effect due to the conjunction of high eductive ability with the demands made by a particular test problem. Similarly, in the entry I_{78} , the statistic for interactions indicates that the various differences in levels of achievement cannot be explained either by differences in eductive ability, taken alone, or by differences in the demands of the two tests, taken alone, or by a merely additive effect of the two, but must be attributed to an enhanced level of achievement produced in particular by the conjunction of high eductive ability and the other abilities required to solve the Logical Memory test, but not found to the same extent when high eductive ability occurs in conjunction with the other abilities required by the Retention test.

The tests used, and the numbers by which they are referred to, are as follows:

1. Jumbled sentences.
2. Number series.
3. Absurdities.
4. Completion.
5. Cancellation A.
6. Cancellation P, R, S, T.
7. Retention.
8. Logical memory.
9. Analogies.

Table 1. *Mean scores*

Test...	1	2	3	4	5	6	7	8
High educative ability	83.9	76.7	63.1	37.8	39.5	42.9	75.4	32.9
Low educative ability	76.3	63.1	46.0	27.2	42.0	44.6	76.1	20.7

Table 2. *Calculated values of the interactions (I_{ij})*

	1	2	3	4	8	5	6	7
1		0.2803	0.2803	—	—	0.5954	0.4462	0.2859
2	0.2803		—	—	—	0.7599*	0.6750	0.5789
3	0.2803	—		—	0.3272	1.1673†	1.0834†	0.9741*
4	—	—	—		—	0.9877†	0.8476*	0.6825
8	—	—	0.3272	—		1.0090†	0.9599*	0.8028*
5	0.5954	0.7599*	1.1673†	0.9877†	1.0090†		—	—
6	0.4462	0.6750	1.0834†	0.8476*	0.9599*	—		—
7	0.2859	0.5789	0.9741*	0.6825	0.8028*	—	—	

* Significant on the 0.05 level.

† Significant on the 0.01 level.

— Where the entry is left blank, the mean square for interaction is less than that for error.

The tests have been rearranged in order, so as to bring out more clearly the points noted in the text.

An examination of Table 2 suggests several points:

(1) The presence or absence of high educative ability affects achievement in tests 1, 2, 3, 4, and 8 in ways so nearly the same that differences between them are completely insignificant. Educative ability operates in almost exactly the same way when it functions in conjunction with any of the other particular abilities required by these tests.

(2) Similarly educative ability operates in almost exactly the same way when it functions in conjunction with any of the particular abilities required by tests 5, 6 and 7.

(3) The way in which educative ability functions in conjunction with the abilities required by the first group of tests is, however, radically different from the way it functions in conjunction with abilities required by the second group of tests. Their occurrence in conjunction tends to enhance achievement in the former, but to produce an effect in the latter which is either neutral or detrimental to achievement.

(4) The only significant exception to this general distinction is test 1, as educative ability appears to operate in conjunction with the abilities required by this test in a way which is not significantly different from that in which it operates in conjunction with the abilities of tests 5, 6 and 7.

(5) I_{35} and I_{36} suggest that test 3 (Absurdities) provides the most striking instance of achievement being enhanced by a co-operation between eductive ability and other particular abilities, while tests 5 and 6 (Cancellations) give the most striking instances of achievement being neutralized by the occurrence in conjunction of eductive and other abilities.

IV. A COMPARISON OF INTERACTIONS AND CORRELATIONS

When the scores of the students, from whom the above two groups were obtained, on the same nine tests, are correlated in the ordinary way, the following Table 3 of Pearson Product Moment Correlation Coefficients is obtained.

Table 3. *Product moment correlation coefficients*

	1	2	3	4	8	5	6	7	9
1									
2	0.3611†								
3	0.3761†	0.2025							
4	0.1840	0.2061	0.2996*						
8	0.3800†	0.2239	0.3780†	0.3589†					
5	0.0422	-0.0084	-0.1479	0.0059	-0.1002				
6	0.2876*	0.1994	-0.0120	0.3001*	0.1484	0.3374*	0.3374*	0.4333†	-0.0503
7	0.1296	0.1065	-0.1962	0.0318	-0.0949	0.4333†	0.2003	0.2003	0.0361
9	0.3966†	0.4014†	0.5161†	0.2850*	0.3326*	-0.0503	0.0361	0.0995	

* Significant on the 0.05 level.

† Significant on the 0.01 level.

When this table is compared with Table 2 above, significant correlations are generally found to correspond to insignificant interactions and vice versa. There are, however, a number of striking exceptions which prevent one's assuming that the same psychological interpretation can be drawn regularly from both high correlations and low interactions, or vice versa.

(a) There are several instances where both correlations and interactions are insignificant: r_{23} and I_{23} , r_{14} and I_{14} , r_{24} and I_{24} , r_{17} and I_{17} , r_{28} and I_{28} , r_{67} and I_{67} . The insignificant correlations in r_{15} , r_{26} , r_{27} , and r_{47} are also accompanied by corresponding insignificant interactions, although in these cases the interactions approach much nearer significance.

(b) There is one case where a significant correlation, r_{46} , is paralleled by an equally significant interaction, I_{46} .

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(c) There are some correlations which are very similar in size, but are paralleled by interactions which differ considerably in size, e.g. r_{14} and r_{26} , r_{17} and r_{68} , r_{34} and r_{46} .

One further detail throws light on differences in interpretation. From the correlations r_{93} and r_{94} the psychologist would normally conclude that the ability required by test 9 could be identified to a much greater extent with the ability required by test 3 than with that required by test 4. The interaction I_{34} however, between the ability required by test 9 on the one hand and those required by tests 3 and 4 on the other hand, is so completely insignificant that the mean square for interactions is actually less than that for error. One must conclude that the way in which the ability required by test 9 operates when it occurs in conjunction with test 3 conditions is indistinguishable from the way it operates when in conjunction with test 4 conditions. It is difficult to reconcile this with the inference drawn from the correlation coefficient.

V. THE NATURE OF THE DIFFERENCE BETWEEN INTERACTIONS AND CORRELATIONS

These differences in interpretation are due to the fact that the statistics for correlations and for interactions measure different features of a complex table of scores. The statistic for correlations is governed primarily by a correspondence of rank order between two sets of scores, and differences either in the standard of achievement or in the spread of the two sets of scores between upper and lower extremes are of relatively minor importance. On the other hand, it is just these features of the table of scores about which the statistic for interactions gives information, and questions of rank order are of minor importance only. A significant interaction indicates that, due to the influence of a factor which may be experimentally controlled, the difference between the standards of achievement of two groups in a particular test is disproportionately greater than the difference between their standards of achievement in another test.¹ Using logical terms, we might say that the calculation of

¹ The statistic for interactions is thus a measure of tetrad differences. A strictly hierarchical table would show no significant interactions. In the method here outlined, however, the statistic is applied to the original data, rather than to correlation coefficients. Interactions and correlations are calculated for the same table of data. The two methods thus supplement and correct each other, as the forms of logical induction are traditionally required to supplement and correct each other before the results of any single method can be considered satisfactory. In ordinary factor analysis, however, the calculation of tetrad differences is applied to correlation coefficients. This appears rather like applying one method of induction to the results obtained by another method, instead of applying them both to a common set of data.

correlations is a statistical form of the method of induction by concomitant variations, while the calculation of interactions is a statistical form of induction by the combined method of agreement and difference. Probably no logician would admit that either of them by itself is capable of giving conclusions which are sufficiently reliable to provide a basis for extended conclusions about the nature of mental abilities. The calculation of correlations, at any rate, when used by itself obviously cannot provide a basis for thoroughly dependable inferences regarding mental abilities, since, as we have seen, its results so frequently conflict with those obtained by the equally valid method of interactions. But when used in conjunction, any results supported by both methods may be depended on.¹

The difference in method can be illustrated in more detail from data already presented. From the mean values given in Table 1 the following may be abstracted:

	Test 4	Test 6	Test 5	Test 8
High educative ability	37.8	42.9	39.5	32.9
Low educative ability	27.2	44.6	42.0	20.7

These entries form two 2×2 tables which are similar in the proportions which the entries bear to each other. Each table contains one test in which the possession of high educative ability tends to produce a greatly enhanced level of achievement, and one in which the possession of high or low educative ability makes no important difference. The values of 'z' for the interactions I_{46} and I_{58} (Table 2) are consequently definitely significant and very similar. The correlation coefficients r_{46} and r_{58} however (Table 3) are very different, one being significantly positive and the other small and negative. These correlation coefficients are based on the use of more data than that used for the interactions, as they are based on the whole table of scores, in the ordinary way, from which the upper and lower thirds were extracted in the calculation of interactions. When the correlation coefficients are calculated for those scores only which were also used in calculating interactions, the coefficients are as follows:

$$r_{46} + 0.3283, \quad r_{58} - 0.2550.$$

The difference between the coefficients is more striking now than before. Moreover, if the correlation coefficients are calculated separately for the high G and low G groups, the r_{46} coefficients for both groups are found to be positive, averaging a little higher than 0.3283, and the r_{58} coefficients for both groups are found to be negative, averaging slightly less than

¹ An example of their use in conjunction will be found in my article on 'Some effects of education in an acquired language', in a recent number of the *Brit. J. Educ. Psychol.*

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-0.2550. It is obvious that the two statistics are based on different features of the tables of scores. Both are legitimate statistics to use.

Of the two, the statistic for interactions can perhaps be given a more definite meaning in experimental procedure, and its use may consequently be freed from some of the ambiguities which tend to vitiate so many inferences based on correlational evidence alone.

VI. CONCLUSION

To sum up, we have found:

(1) That the statistic for interactions can be calculated for all psychological data which are normally analysed by correlational methods.

(2) That it can be used with the greatest advantage to supplement and correct information obtained by the calculation of correlations.

(3) That it is a valuable tool for estimating the extent to which certain factors, functioning in conjunction with each other, produce effects explicable neither by reference to any or all of them functioning in isolation, nor by a merely additive effect of their respective contributions.

(a) It can be used with the greatest advantage to discover those interrelationships of mental abilities by virtue of which they function, in conjunction, in this non-additive way.

(b) It can also be used to advantage to isolate those particular characteristics in conjunction with which a given difference of social importance produces significant effects.

The study of how our mental abilities co-operate when applied in conjunction to the solution of a complex problem is of the utmost importance for psychology. As the statistic for interactions is designed to give information on just such problems, and as there is a valid measure for determining its significance, it could be extensively used, with decided advantage, in the analysis of quantitative psychological data.

REFERENCES

- (1) FISHER, R. A. (1938). *Statistical Methods for Research Workers*. Edinburgh: Oliver and Boyd.
- (2) SNEDECOR, G. W. (1934). *Calculation and Interpretation of Analysis of Variance and Covariance*. Iowa: Ames.

(Manuscript received 5 August 1941)

NOTE

In Table 1 on p. 140 of the paper by Boris Semeonoff, 'Dark Adaptation during Stimulation with Coloured Light' (this *Journal*, xxxii, Part 3), the heading "in." should read "min."

PUBLICATIONS RECENTLY RECEIVED

The Cambridge Evacuation Survey. Edited by SUSAN ISAACS, with the co-operation of SIBYL CLEMENT BROWN and ROBERT H. THOULESS. Contributions to Modern Education, edited by Susan Isaacs. London: Methuen and Co., Ltd. 1941. Pp. ix + 235. 8s. 6d. net.

This book is sure of a welcome among psychologists, since it is the first to give a full and detailed psychological study of a group of evacuated children, both those who stayed and those who went back. Out of over 3000 school children evacuated to Cambridge in September 1939, rather over 1000 remained in July 1940. But the main part of the study was confined to 300 children from Tottenham, made during December 1939; 350 children from Islington, made during the spring and early summer of 1940; and 69 Tottenham children and 81 Islington children who returned to London before these dates. Questionnaires relating to the children in Cambridge were sent out to the billeting officers, asking for information about the foster homes, the attitude of the foster parents to the evacuated children, and the behaviour of the child and its parents. These children also wrote essays on "What I like in Cambridge" and "What I miss in Cambridge". Forty children badly adapted to their foster homes were personally interviewed and tested, and compared with a control group of 40 well-adjusted children; and additional data were obtained from other children referred to the Child Guidance Clinic. The families of the returned children were interviewed personally by trained social workers. From the results of the data obtained from the Cambridge children, a useful Memorandum on Practical Recommendations was drawn up and circulated among Public Authorities, etc. This Memorandum, which is given in full, is admirable, and should be studied carefully by everyone interested in evacuation.

The main points that emerged from the survey were that, according to the questionnaire data, only 8.2% of the children were definitely unhappy in their billets, but that, among the Tottenham children, the proportion was much higher among adolescents than among younger children. The presence of siblings in the same billet made for greater happiness; so also did fairly frequent visits from parents. Difference in economic status between parents and foster parents seemed to have little effect on happy adjustment. From the more detailed studies it appeared that misfits could often have been avoided by billeting the more lively children in families with youngish foster parents and other children; and the quieter and more withdrawn children in homes with older foster parents and no other children. The most boisterous and aggressive type of child was always likely to be a problem; and there was a certain number of difficult cases who could only be dealt with by institutional treatment. But there was no evidence of widespread emotional maladjustment arising simply as the result of evacuation, either among the children in Cambridge or those who had returned. In many cases there was an improvement of health. The main factors which caused return were (a) anxiety or loneliness of the parents and/or children, (b) parents' dissatisfaction with the foster home, (c) parents' poverty—cost of billeting, clothes, visits, etc. But there seemed to be little evidence of any general grudge against evacuation as such.

This book is so interesting and so well written and constructed that it seems ungracious to carp at it. Indeed the authors themselves forestall criticism on many points. It is of course obvious that the sample studied was too small and limited in range and variety to give much reliable indication as to the effects of evacuation in general. For this reason, the use of questionnaires and statistical methods seems rather

inappropriate. Little reliance can be placed on any except purely factual information obtained from those untrained in answering questionnaires; and too much weight seems to have been given to the answers to the question, "Is the child happy?" But very useful data relating to the child's underlying psychological attitudes and reactions to evacuation might have been obtained by an intensive study such as those which Dr Isaacs has carried out in the past. Here, however, the individual case studies were neither sufficiently numerous nor detailed and 'deep' to give much information of this kind.

Thus the book seems rather to fall between two stools, the sociological and the psychological, when it might more profitably have been confined to either. But it is useless to demand what no doubt the circumstances of the moment made it impossible to provide; and we must welcome the book as it stands.

M. D. V.

Change. Clothes Rationing Survey: An Interim Report prepared by MASS-OBSERVATION. London: No. 1 Bulletin of the Advertising Service Guild. 1941. Pp. vi+85. 1s. net.

From the point of view of the Clothing and Advertising trades it was no doubt important to gain an impression as rapidly as possible as to the effects of rationing upon the British public and its 'clothes habits'. Unfortunately it seems to have been a case of "more haste, less speed". The mind of the British public moves too slowly for it to be able to decide, within the space of about a month, what alterations if any it is likely to make in its buying and wearing of clothes. The general impression is that most people were resigned to rationing, and that they did not anticipate much alteration in their manner of dressing, except that they would worry less about smartness and social standards of dressing (this especially among men).

In a brief report such as this it was no doubt impossible to describe in detail exactly how the information was obtained (methods of sampling, interviewing, etc.). But we are told that 300 people in each of three towns, London, Worcester and Bolton, were given a verbal questionnaire, which is quoted in full. The persons questioned were selected with a view to obtaining a representative survey of all classes and types of occupation. Also various supplementary reports were obtained, from "Mass-Observation voluntary workers" and others. The data seem sufficiently reliable to allow the acceptance of the rather negative conclusions of the Report. But the small size and narrow distribution of the samples would necessitate great caution in accepting any positive trends, which might be largely influenced by individual idiosyncrasy.

Nevertheless, the Advertising Service Guild are to be congratulated on its publication of this Report. Perhaps it will see its way in future to commissioning larger and more detailed surveys.

The Difficult Child and the Problem of Discipline. By C. W. VALENTINE. London: Methuen and Co., Ltd. 1940. Pp. viii+104. 4s. net.

This book is addressed mainly to parents and teachers, with a view especially to removing the misconceptions about child psychology which they may have acquired from the writings of foolish enthusiasts and sensational journalists. If indeed there are those who still swallow these stupid exaggerations and model their treatment of children upon them, the advice, which is lucidly given, should be valuable. One wonders if there are many, however—except the credulous and unbalanced individuals who are beyond the reach of good advice. It is perhaps a pity that the author gives the impression, in Part I of the book on Psychology and the Difficult Child, of underrating the value of the knowledge and understanding of children which psychologists have contributed, and of their ability not only to alleviate but to cure out of hand many of the maladjustments of childhood. It is not so much a question of

normality or abnormality, but of removing in childhood difficulties which if neglected may impair adult happiness and stability. In these days Child Guidance (and all that it implies) needs every encouragement that it can get; and not until the last chapter of the book does the author really give it its due. In particular, he lays far too little stress on the vital importance of 'play' in the child's life. It is true that a direct interpretation given to the child of the meaning of his play should be undertaken only with caution and never except by the experienced play therapist. But parents and teachers should be urged to give all possible facilities and encouragement to free, imaginative and constructive play for the younger child, and occupations giving opportunities for imaginative expression in the older child. These can harm no one, and may help very many. Even destructive play may be valuable, and can be confined to suitable activities such as wood-chopping.

But these criticisms should not blind the reader to the interest and value of the book, particularly of Part II on the Problem of Discipline, which should be most helpful. It indicates how to steer a safe course between undue repressiveness and laxity in the treatment of children, stressing the importance of helping the child to acquire the measure of self-discipline possible at any given age. Prof. Valentine hedges a little on the problem of corporal punishment. The work of Hopkins may show what the child thinks about corporal punishment. But, apart from anecdotal evidence, has any one demonstrated any lasting *good* effect produced by it?

However, it is to be hoped that many parents and teachers will be guided and reassured by the sound conclusions that Prof. Valentine has so clearly and attractively expressed.

The Constancy of the Intelligence Quotient in Subnormal Children. By GILBERT E. PHILLIPS. Publications of the Australian Council for Educational Research. Melbourne University Press (London: Humphrey Milford, Oxford University Press). 1940. Pp. 86. 5s. net.

This monograph gives a rather lengthy and confused account of a piece of work, interesting in itself, which could nevertheless have been adequately described in a Journal. The intelligence quotients of 365 children at a residential Special school were measured, by means of the Stanford Binet test, at intervals over a period of nine years (though only 100 children actually completed five testings). The average I.Q. for the whole group was found to decline over this period. This was due, not to a progressive decline of all cases, but to the fact that certain children, particularly those of low I.Q. and unstable emotionality, 'matured' early. That is to say, their mental age did not increase regularly up to the age of fifteen, but became constant, in two cases before the age of eleven. It is clear, therefore, that prediction of the future intelligence level cannot be made with any certainty with such children, especially if tested only when quite young. However, for nearly 60% of the children tested, the Binet test gave a reliable measure of intelligence with a constant I.Q. up to fifteen years.

It seems a pity that no further study was made of the type of child who reaches this early 'maturity' ('standstill' seems a better term for it). But the conclusions reached seem well established and reasonable.

Psychological Studies in Dementia Praecox. By ISABELLE KENDIG and WINIFRED V. RICHMOND. Ann Arbor, Michigan: Edwards Brothers, Inc. 1940. Pp. x+211.

This interesting monograph is based upon the results of testing, with the Stanford Binet test, 500 hospitalized dementia praecox cases, together with a number of normal and mentally deficient adults for comparison. In addition, forty-one of the former,

whose case histories are given, were re-tested after an average period of ten years. The purpose of the study was to find if there were any evidence of an irreversible deterioration in intellectual ability. The authors found none. Mental age averaged below normal, but many of the patients had shown poor intellectual ability during their school days before the onset of the psychosis. Previous suggestions were confirmed that such impairment of intellectual ability as appeared was functional only, and was largely determined both in degree and pattern by pre-psychotic intellectual capacity. There was no differential mental age score between the vocabulary test and the other Binet tests; thus the theory of Babcock that the former indicates the undeteriorated pre-psychotic mental level, as against the deterioration shown on the other tests, is not confirmed. On the other hand, performance in tests requiring relatively great expenditure of attention and effort was adversely affected by the withdrawn and inhibited state characteristic of the psychosis. Although the authors confined their studies to the results of Binet testing, it seems fairly clear that no structural deterioration of any particular mental 'faculty', e.g. imagination, or abstract reasoning, exists in dementia praecox, though there may be impairment of mental energy, due to emotional blockage.

Germany Possessed. By H. G. BAYNES. With an Introduction by HERMANN RAUSCHNING. London: Jonathan Cape. 1941. Pp. 305. 16s. net.

It is a matter of great interest to see how the Jungian school reacts to the horrors and chaos of the present war, which seems to provide so clear and obvious an example of the irruption of the 'collective unconscious' at its most primitive and violent. Dr Baynes has taken full advantage of this opportunity. In the first few chapters of his book it seems that here at last we are being given a coherent and consistent account of the application of Jungian theory to a large-scale practical case. The picture of Hitler as the 'shaman' who relies on his collective unconscious to release the inhibited functions of the collective unconscious of the German people, believing himself a Siegfried to the German Wotan, enables us to understand how so undistinguished an individual should be capable of such immense 'drive' and cleverness. But convincing as is the analysis of Hitler's mentality, by comparison the analysis of the mentality of his followers is relatively 'thin' and obscure. Perhaps it is impossible for us fully to understand why Hitler with his power lust appears to his followers as saviour rather than as madman; or to see how a whole, or the major part of, a nation can succumb to the intoxicated violence of unrestricted collective unconscious activity. Apparently the restraints of tradition and custom are adequate to prevent any similar breakdown in this country, without being so repressive as to inhibit all freedom of action. But in the latter part of the book the author seems somewhat to lose his grip of the argument, which becomes repetitive and moves circularly about the point from which it started rather than proceeding logically forwards. The definitive and clearly comprehensible exposition of the Jungian theory is yet to come. Nevertheless, both the psychologist and the general reader should find the ideas presented in the earlier part of the book interesting, suggestive and well worth studying. And it is of particular importance in providing a reasoned antidote to the superficialities of the scientific materialists, which are so inadequate to the understanding of the present situation.

The Psychodynamics of Abnormal Behaviour. By J. F. BROWN. London: McGraw-Hill Publishing Co., Ltd. 1940. Pp. xvi + 484.

It would be most interesting to see some attempt at a systematic integration of the Freudian theory and Lewin's Dynamic psychology, since the two systems have much in common, and much to learn from each other. Both Lewin himself and his disciple J. F. Brown have written papers on the subject, but these have appeared in obscure

American publications unobtainable in this country. Consequently English readers will be disappointed after noting the title of this book to find that it contains no more than a brief and sketchy account in the last chapter of the similarities between the theories and findings of Freud and Lewin. The rest of the book consists of a rather uninteresting exposition of abnormal psychology, with sections on Symptomatology, The Theory of the Structure and Genesis of Personality (mainly the Freudian theory), and Psychiatry. It is no better and no worse than the many similar books on abnormal psychology; except that the author cannot evade his 'King Charles's head'—his dislike of Christianity.

Superstition and Society. By R. MONEY-KYRLE. Psycho-analytical Epitomes No. 3. London: the Hogarth Press and the Institute of Psycho-analysis. 1939. Pp. x+163. 4s. 6d. net.

This book gives a readable exposition of the Freudian interpretations of mythology, superstition, magic and taboo. It is mainly based on Freud's *Totem and Taboo*, but the original Freudian theory is expanded by Dr Money-Kyrle in accordance with his own views—those on anthropology being interesting and plausible, those on education less so. Whether this kind of popularization of Freudian explanations is desirable seems rather doubtful. The whole theory is too speculative and subject to modification—in parts symbolically rather than factually correct. Popular expositions give it a fictitious clarity, definiteness and conclusiveness which is often misleading.

Civilization, War and Death. Selections from three works by SIGMUND FREUD. Edited by JOHN RICKMAN. Psycho-analytical Epitomes No. 4. London: the Hogarth Press and the Institute of Psycho-analysis. 1939. Pp. viii+102. 3s. 6d. net.

This book contains extracts from *Thought for the Times on War and Death* (1915), translated by E. Colburn Mayne; *Civilization and its Discontents* (1929), translated by Joan Riviere; and *Why War?*, an open letter to Prof. Einstein (1933), translated by Stuart Gilbert.

My Life. By HAVELOCK ELLIS. London: William Heinemann, Ltd. 1940. Pp. xviii+542. 15s. net.

Reading this book prompts the reflexion that the art of writing autobiography lies in selection. To describe certain parts of one's life and thoughts in the minutest detail (it is obviously impossible to describe all) is confusing to the reader, who is unable to see the wood for the trees. Moreover, the recounting of certain intimacies does not create an impression of frank disclosure so much as of a rather embarrassing exhibitionism. The conclusion is that Havelock Ellis can be best known and most highly valued from the sympathy and understanding displayed in his works on the psychology of sex.

The Myth of the Mind. By FRANK KENYON. Thinkers' Library No. 85. London: Watts and Co. 1941. Pp. ix+115. 1s. 3d. net.

This book is an exposition of the familiar hypothesis that the mind can be identified with the brain. To prove this, the author attempts to describe certain mental phenomena about which a fair amount is known in terms of central nervous processes about which very little is known; while ignoring those mental phenomena which cannot by any stretch of our present knowledge be treated in this way. It seems rather a pity that this book should be included in a 'Thinkers' Library'.

BRITISH PSYCHOLOGICAL SOCIETY

REVENUE ACCOUNT AND BALANCE SHEET AS AT 30 SEPTEMBER 1941

Revenue Account for the year ended 30 September 1941

[illegible]

Balance Sheet as at 30 September 1941

LIABILITIES			ASSETS		
1940	£	s. d.	1940	£	s. d.
Sundry Creditors ...	...	...	Cash at Barclays Bank Ltd. ...	...	...
Rent receivable in Advance	...	...	Postage Stamps in hand ...	...	...
Subscriptions in Advance	...	...	<i>Investments at Cost:</i>		
<i>Publications Reserve:</i>			£300 5% Conversion Loan 1944-64 ...	318	9 9
Balance as per last Balance Sheet ...	...	...	£3514. 9s. 6d. 3½% Inscribed War Loan ...	3625	7 9
<i>Revenue Account:</i>			<i>Note: Market value of above Securities at 30 September 1941, £4040</i>		
Balance as per last Balance Sheet ...	5352	0 6	Rent, 55 Russell Square, paid in Advance		3943 17 6
Add Surplus of year ...	236	4 3			
	5352	0 6	Sundry Debtors ...	...	...
			Subscriptions in Arrear ...	...	...
			<i>Office Furniture and Fittings:</i>		
			Balance as per last Balance Sheet ...	209	18 6
			Add Expenditure during year ...	11	12 11
				221	11 5
			Less Depreciation ...	22	1 5
				209	18 6
			<i>Library:</i>		
			Balance as per last Balance Sheet ...	561	3 0
			Add Expenditure during year ...	22	9 7
				583	12 7
			Less Depreciation ...	58	2 7
				561	3 0
			<i>Monograph Publications:</i>		
			Balance as per last Balance Sheet ...	130	13 5
			Less Amounts repaid during year ...	18	17 5
				130	13 5
			Shares in the British Journal of Educational Psychology Ltd., at Cost ...		111 16 0
				50	0 0
				£5747	18 8
				£5436	10 6

I beg to report that I have examined the foregoing Accounts with the Books and vouchers of the British Psychological Society and that I have obtained all the information and explanations I have required. In my opinion the Balance Sheet is properly drawn up so as to exhibit a true and correct view of the state of the Society's affairs according to the best of my information and the explanations given to me and as shown by the Books of the Society. The Securities appearing under the heading Investments have been verified by production of the Bankers' Certificate.

T. BARRETT,
Incorporated Accountant

29 October 1941.

S. J. F. PHILPOTT,
Hon. Treasurer